RECAP

ABSTRACT OF REPORT

ON THE

ORIGIN AND SPREAD OF TYPHOID FEVER IN U. S. MILITARY CAMPS DURING THE SPANISH WAR OF 1898

BY

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INTRODUCTION.

The assembling of 250,000 volunteer troops in military camps within a short time after the declaration of war against Spain in the spring of 1898 taxed all the bureaus of the War Department to the utmost. The Medical Corps of the Regular Army was barely sufficient for our little Army of 25,000 men. To this corps of trained medical officers were suddenly added 115 commissioned medical officers of volunteers and 382 medical officers of State organizations, most of whom had had no previous military experience. Owing to the extensive prevalence of typhoid fever in our camps, it became necessary at a later date to reenforce this enlarged corps of medical officers by the employment of contract surgeons. The number of contract surgeons in service on June 30, 1898, was 151; July 31, 272; August 31, 512; September 30, 564. At the same time the Hospital Corps of the Army, which before the war consisted of 520 privates, most of whom were tolerably well trained, had to be expanded by the addition of 6,588 recruits, who for the most part were entirely untrained and consequently unfit for the responsible duties of nursing seriously ill men. It therefore became necessary to send to our general and camp hospitals trained female nurses, whose services were highly appreciated by our medical officers generally, and, indeed, under the circumstances, were indispensable. The number in service on June 30, 1898, was 23; July 31, 162; August 31, 924; September 30, 1,065.

The enormous task which confronted this enlarged Medical Department is shown by the fact that more than 20,000 cases of typhoid fever occurred among our troops encamped within the limits of the United States during the months of May, June, July, August, and September, 1898. The causes for this extensive prevalence of a fatal infectious disease are fully set forth in the exhaustive report made by the board of medical officers convened by my request (Special Order 194, Adjutant-General's Office, August 18, 1898). I regret that it is not practicable at the present time to publish this report in extenso. It consists of 2,600 typewritten manuscript pages, and is accompanied by 5 maps and many plans of camp sites, 84 graphic charts showing the prevalence of typhoid fever, intestinal disorders, and malarial infections in the various volunteer regiments, and 9 charts showing the meteorological conditions prevailing at the principal camps during the period to which the report relates. The report

as a whole will for the present be placed in the library of the Surgeon-General's Office, where it may be consulted by those desiring to see the original data upon which the conclusions of the board are based. In order that these conclusions may be available for the use of the profession at the earliest practicable date, the following abstract of the report is now published. I desire to express my high appreciation of the able and painstaking manner in which the board has accomplished the task imposed upon it, and also to express my sincere regret at the death of Maj. Edward O. Shakespeare, surgeon, U. S. Volunteers, which occurred very shortly after he had completed his arduous labors as a member of this board.

GEO. M. STERNBERG,
Surgeon-General U. S. Army.

LETTER OF TRANSMITTAL.

The SURGEON-GENERAL U. S. ARMY.

SIR: I have the honor to forward herewith the report of the board of medical officers convened per Special Orders, No. 194, Adjutant-General's Office, August 18, 1898. In submitting this report, which gives the results of the board's investigation into "the cause and extensive prevalence of typhoid fever in the various military camps within the limits of the United States," I desire to bear witness to the unremitting labors of the volunteer members of the board, Majs. Victor C. Vaughan and Edward O. Shakespeare. Although honorably discharged from the service of the United States on June 30, 1899, at a time when this report was far from being completed, these gentlemen voluntarily continued to give their services to the Government, to the entire exclusion of their private interests; the former until January 31, 1900, and the latter until the day of his death, June 1, 1900. Whatever scientific value, therefore, the report of this board may possess, must be largely credited to the untiring efforts of its volunteer members. I desire also to call attention to the invaluable assistance rendered the board during the past two years, in the preparation of tables, charts, etc., by Mr. C. J. Myers, chief clerk, Army Medical Museum.

Very respectfully,

WALTER REED,
Major and Surgeon, U. S. Army,
President of the Board.

SPECIAL ORDERS, No. 194.

WAR DEPARTMENT,
ADJUTANT-GENERAL'S OFFICE,
Washington, August 18, 1898.

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40. A board of medical officers, to consist of Maj. Walter Reed, surgeon, U. S. Army; Maj. Victor C. Vaughan, division surgeon, U. S. Volunteers, and Maj. Edward O. Shakespeare, brigade surgeon, U. S. Volunteers, is appointed to meet in this city at the earliest date practicable for the purpose of making an investigation into the cause of the extensive prevalence of typhoid fever in the various military camps within the limits of the United States, under such instructions as it may receive from the Surgeon-General of the Army. The board will call the attention of the proper commanding officers to any insanitary conditions which may exist at the camps visited by it, and will make recommendations with a view to their proper correction.

The report of the board will be forwarded to the Surgeon-General as soon as practicable after the completion of the investigation contemplated.

Such journeys as may be required under the above order are necessary for the public service.

* * * * * * *

By order of the Secretary of War:

H. C. CORBIN,
Adjutant-General.

INTRODUCTION TO THE STUDY OF TYPHOID FEVER IN THE FIRST, SECOND, THIRD, FOURTH, AND SEVENTH ARMY CORPS.

It will be well to explain the method pursued in the study of typhoid fever in these several organizations.

In compliance with the order convening the board we visited and carefully inspected all of the larger encampments in the United States, viz, Camp Alger, Va.; Camp Cuba Libre, Jacksonville, Fla.; Camp George H. Thomas, Chickamauga Park, Ga., and Camp Meade, Middletown, Pa. We also inspected the camps at Fernandina, Fla., Huntsville, Ala., Knoxville, Tenn., and Wycoff, N. Y. In making this inspection, which covered the period from August 20 to October 10, 1898, we endeavored to ascertain by the testimony of medical officers, especially the regimental surgeons, and by direct personal observations all the facts ascertainable with regard to the origin and spread of typhoid fever in the several commands. We acquainted ourselves with the water supply, the nature of the soil of the camp site, the space allotted regiments, the arrangement and size of the tents and the number of men occupying each tent, the disposal of excreta, the location of sinks with reference to mess tents, the disposition of garbage, the care given to the conditions of sinks and cesspools, and the thoroughness with which the camps were policed. Not only did we try to elicit all the data obtainable on these several points in the larger encampments, but we were also particular to bring out all the evidence possible with regard to the water supply, the character of the camp site, the disposal of excreta, and the prevalence of disease in the various State encampments. We visited regimental, division, and other hospitals and ascertained the methods of disinfection practiced in these hospitals. In short, we endeavored to see for ourselves everything that might have a bearing on the origin and spread of typhoid fever.

Upon our return to Washington we found ourselves in possession of more than 1,000 typewritten pages of testimony given by medical officers, all of which bore in one direction, viz, to the conclusion that typhoid fever in our several camps was due to the contamination of the water supply.

We next began the study of the records of the Surgeon-General's Office. These consisted of the reports of sick and wounded made at the end of each month by the regimental surgeons. In the study of the regiment, which we have taken as the unit, we have first carefully examined the monthly sick report made by the surgeon in charge. After a thorough study of the regimental records, we have gone through the division and general hospital records, and have endeavored to trace as fully as possible the history of every prolonged illness in the regiment, especially those of intestinal origin or of a febrile character, no matter under what diagnosis recorded. We have made a special effort to determine when the first case of typhoid fever appeared in the regiment. In doing this we have given the date of the first case of "probable" typhoid fever and that of the first case of "recognized" typhoid fever. Of course, in many instances these dates are the same, because the first case of probable typhoid fever was recognized as that disease. In the case of the First and Third Army Corps we have made from the regimental records a list, including the name, rank, and company, of every man who was sick ten days or longer. After doing this we have taken the hospital records and ascertained as far as possible the disposition of each of these cases. In the case of the First and Second divisions of the Second Army Corps and the Second and Third divisions of the Seventh Army Corps we have copied out the name, rank, company, and regiment of every officer and soldier sick with any germ of intestinal or febrile disease.

We have followed these through regimental, division, general, and State hospitals, and have ascertained the duration of the attack and any changes in diagnosis that might be made. In 32 regiments of the Second Army Corps and in 16 regiments of the Seventh Army Corps we have traced the subsequent history of every enlisted man having a short diarrhea or supposed mild malarial attack, in order to see whether these individuals afterwards showed any immunity to typhoid fever. Having endeavored to ascertain with every degree of accuracy within our power the number of cases of typhoid fever in 118 regiments, we found that the data were more or less incomplete in 20. Of the remaining 98 regiments we have charted by company and regiment 84. In 60 of these regiments all cases of typhoid fever, all short and long malarias, and all diarrheas are indicated on the charts according to the date of their occurrence. Of the remaining 24 regiments only cases of typhoid fever are charted.

Bearing on the possibility of infection by personal contact, we have endeavored to locate by tents and in the order of their occurrence every case of typhoid fever which developed in a number of regiments of the Second and Seventh Army Corps, especially in the Fifteenth Minnesota, Thirty-fifth Michigan, Two hundred and third and Two hundred and first New York, and Second New Jersey Volunteer

Infantry. These data were furnished largely by the medical officers of these regiments, and in part by the captains of 15 companies of regiments belonging to the Second and Seventh Corps.

It will be readily seen that in prosecuting this work we have assumed a task not only of great magnitude but one beset with many difficulties. The incompleteness of regimental medical records, the changes in the spelling of names, the giving of initials, and the statement of rank and company have given us no end of trouble. However, we have spared no pains and we believe that we have not duplicated cases. In the case of men who were furloughed we have carefully searched the reports of mustering-out officers; and in ascertaining the names of those who have died and the cause of death, we have resorted to the records of the Adjutant-General's Office. Many men were sent home on hospital trains and were distributed in civil hospitals throughout the country. The medical officers of these hospitals have, as a rule, been kind enough to send us detailed reports giving the name, regiment, rank, company, diagnosis and termination of each case. In a few instances hospital officials have refused to make such reports, hence we have not secured reports from all the civil hospitals. However, in some of these institutions in which the superior officers have refused to supply us with the desired information physicians in immediate charge of patients have at considerable sacrifice of time made out the desired lists for us. To all of these we wish to express our warmest thanks. We are particularly indebted to Maj. David C. Peyton, surgeon, U. S. Volunteers, for complete reports of sick from the various State and city hospitals of Pennsylvania.

Having ascertained when the first case of typhoid fever appeared in each regiment, we have endeavored to trace the progress of the disease and to account when possible for its spread. Especial attention has been given to the effects of the movements of regiments, the sites of camps, the water supply, and the disposition of fecal matter upon the spread of the disease.

It will be seen that we speak of "recognized" or "certain" and "probable" cases of typhoid fever. The recognized or certain cases need no comment nor explanation. By "probable" we refer to cases which were not recognized by any of the military medical officers as typhoid fever, but which we believe to have been cases of this disease. We have kept these two classes distinct in order that our statistics may not be vitiated by our own ideas. When we began the inspection of camps and hospitals, we soon saw that many medical officers were, in our opinion, failing in the recognition of typhoid fever. Immediately we asked the Surgeon-General to send to each encampment an expert properly equipped to make blood examinations for the plasmodium of malaria and to apply the Widal test for typhoid fever. It is to be regretted that these examinations were not begun earlier. However, we have been able through these experts to clear up the diagnosis in a large proportion of the cases. In many places our

report will apparently be a reflection upon the professional skill of the medical officers. This reflection is, however, more apparent than real. We wish to testify to the fact that the medical officers, both in the volunteer and the regular service, were men of more than average professional ability. It is true that weak men were found in both lines of service, but these were the exceptions and not the rule. The fact that so large a number of most competent medical men left their remunerative practice to devote their time and energy to the service of their country, with most inadequate compensation, must always be accounted to the credit of our profession. In extenuation of the fact that medical officers failed to recognize many cases of typhoid fever, it must be said that the regimental medical officer had the majority of these cases under observation for so short a time that with the means at his command it was quite impossible in a large percentage of the cases to make a positive diagnosis. The rules required that all cases of sickness of forty-eight hours' duration should be sent to the division hospital. This rule is a wise one, and it is unfortunate that it was not always obeyed. It is undoubtedly true that typhoid fever was often spread through a regiment by keeping cases of this disease in quarters or in regimental hospitals, where provision for the disinfection of stools and the care of patients were wholly inadequate, to say nothing of the fact that the time of the regimental medical officer was so occupied with matters pertaining to camp sanitation and with the care of numerous cases of temporary illness that he was not able to give sufficient attention to those sick with typhoid fever. Moreover, regimental medical officers were frequently detached from their commands and placed on duty in division hospitals or elsewhere.

It will be seen from figures to be given later, in which we compare the mortality from typhoid fever in the Army with that from the same disease in civil practice, that the army surgeon in his failure to recognize all cases of typhoid fever showed no greater incapacity than that which is daily shown by physicians in many of the larger cities in our country.

In our list of "probable" cases of typhoid fever it is to be presumed that we have included a few which were not actually cases of this disease. However, we think that the death rate among the cases of probable typhoid fever shows that we have not overestimated the number. Be this as it may, we have endeavored to give every fact that we could obtain concerning each case. We have endeavored to make this report a full and complete statement of facts, from which we have drawn certain conclusions. The facts are placed before the reader; these he must accept. With our conclusions he may agree or he may draw others to suit himself. In endeavoring to state all the facts, we have made this report somewhat voluminous, but we think we have been justified in doing this. Our sole endeavor has been to get as near the absolute truth as possible.

CHAPTER I.

TYPHOID FEVER IN THE FIRST DIVISION, FIRST ARMY CORPS.

Commands.—First Kentucky, Third Wisconsin, Fifth Illinois, Fourth Ohio, Third Illinois, Fourth Pennsylvania, Sixteenth Pennsylvania, Second Wisconsin, and Third Kentucky.

GENERAL REMARKS.

It is quite certain that most, if not all, of the regiments of this division reached Chickamauga with one or more men infected with typhoid fever. The number of cases of probable typhoid fever developed in this division, with a mean strength of 11,339 officers and men at Chickamauga Park, may be tabulated as follows:

Commands.	Arrived.	Left.	Number of cases.
First Brigade.			
1st Kentucky	June 11	July 26	22
3d Wisconsin	May 15	July 5	49
5th Illinois	May 17	Aug. 13	47
Second Brigade.			
4th Ohio	May 16	July 22	19
3d Illinois	May 17	do	60
4th Pennsylvania	May 16	July 23	26
Third Brigade.			
16th Pennsylvania	May 17	July 6	17
2d Wisconsin	do	do	54
3d Kentucky	June 2	July 28	39

It may possibly be of interest to endeavor to ascertain whether or not the rapidity with which typhoid fever spread among the different regiments was in direct proportion to the number of infected men in the regiment when it reached Chickamauga. We do not suppose that this question can be answered conclusively and positively, but the inquiry may be of some interest. We will compare the Third Illinois with the other regiments of the same brigade. Practically the regiments of this brigade came to the park and left at the same time. During the fourteen days that remained of May, after the arrival of the Third Illinois, this regiment developed 9 cases of probable typhoid fever. We will suppose that all of these were infected before the regiment reached Chickamauga. Then we may say that this regiment had within itself 9 foci for the distribution of the disease and from these foci there were developed, up to July 22, 60 cases of probable

typhoid fever. During the fifteen days that remained of the month of May, after the arrival of the Fourth Ohio, there developed in this regiment 6 cases of probable typhoid fever, and from these 6 foci there developed, up to July 22, 19 cases of probable typhoid. During the fifteen days that remained of the month of May, after the arrival of the Fourth Pennsylvania, there were no cases of typhoid fever in this regiment and 26 cases developed by July 23. We have carried out this line of inquiry in several brigades and have reached the general conclusion suggested by the above-given figures, i. e., there is no constant relation between the number of men infected with typhoid fever in a regiment at the time of its going into a camp and the number that developed the disease outside of those previously infected within a given time. The explanation for this is not difficult to find. The means for the spread of the infection must vary in every command.

There is one point in connection with the camp of the Second Brigade of the First Division at Chickamauga, which may be worthy of consideration. From April 22 to 30, 1898, the Sixteenth U. S. Infantry was encamped in Chickamauga Park. At this encampment at this place this regiment reported no sickness, but soon after it reached Tampa in May, 1898, it reported 13 cases of acute intestinal catarrh, 3 cases of diarrhea, and 3 cases of typhoid fever. When the Second Brigade of the First Division of the First Army Corps was located in Chickamauga Park, the regimental camp of the Third Illinois occupied a part of the site recently vacated by the Sixteenth U. S. Infantry, while the other regiments of this brigade were placed some distance away. It is possible that the Sixteenth U. S. Infantry might have infected the ground subsequently occupied by the Third Illinois. As an isolated instance, this fact can have no great significance; but we have found numerous similar instances, and we are strongly of the opinion that only in case of the most urgent military necessity should any command be placed on a site recently vacated by another.

It must be evident from the histories of the regiments of this division that military organizations after becoming widely infected with typhoid fever do not lose this infection on changing locality of camp, even when all the sick are left behind and the site to which the command removes is free from infection. The infection is carried in the bodies of the men, in their clothing, bedding, and tentage. Thorough disinfection of everything in addition to change of location is necessary in order to stamp out typhoid fever after it has become widely distributed in a command.

We have not been able to obtain the records of the hospital of this division.

Summary of deaths in the First Division of the First Army Corps.

Commands.	Total deaths.	Deaths due to typhoid fever.
First Brigade.		
1st Kentucky	28	18
3d Wisconsin	36	24
5th Illinois	16	8
Total	80	50
Second Brigade.		
4th Ohio	26	19
3d Illinois	44	25
4th Pennsylvania	35	24
Total	105	68
Third Brigade.		
16th Pennsylvania	40	34
2d Wisconsin	41	27
3d Kentucky	17	11
Total	98	72

Total deaths	283
Deaths due to typhoid fever	190
Percentage of deaths from typhoid to total deaths	67.49

CHAPTER II.

TYPHOID FEVER IN THE SECOND DIVISION OF THE FIRST ARMY CORPS.

Commands.—Thirty-first Michigan, One hundred and sixtieth Indiana, First Georgia, One hundred and fifty-eighth Indiana, Sixth Ohio, First West Virginia, First Pennsylvania, Fourteenth Minnesota, and Second Ohio.

GENERAL REMARKS.

It seems to us more than probable that the water supply for this division during May, June, and July at Chickamauga became infected with the specific poison of typhoid fever. We think that this was most probably true of the Jay's Mill well, from which the First and Second brigades obtained their water supply in part, and of the Brotherton Road well, from which the Third Brigade obtained its water supply for some time after its arrival. The location of both of these wells with reference to the camps which they supplied, together with the fact that these camps were infected, renders it much more than probable that the water of these wells became infected with typhoid fever. We are quite positive in our belief that water infection was one of the means by which typhoid fever was spread through this division while at Chickamauga. It is unfortunate that proper bacteriological studies of these waters could not have been made at the time. As has already been stated, we see no reason for believing that these wells were infected when the troops arrived. In fact, we have already given strong reasons for believing that these wells were

not infected at that time. Employees about the park had long been accustomed to drink these waters, and typhoid fever had not followed. The water from these wells did not introduce typhoid fever among the troops. The troops brought the disease, infected the water, and then drank it. We do not make these statements as demonstrated facts, but as the opinions which we have reached as a result of our study.

However, water was not the only means by which typhoid fever was spread among the troops of this division at Chickamauga. Like all other organizations in the park at that time, the camps of the regiments of this division became terribly polluted. Sinks could not be properly constructed. Their contents were not kept covered or even kept within bounds, but overflowed and polluted the soil about them. Flies swarmed alternately about the sinks and the mess tents. Men carried infected filth on their persons and in their clothing. Tents, blankets, and equipage in general became infected, and when this division moved to Knoxville it carried with it innumerable cultures of the typhoid bacillus.

At Knoxville the water supply was not contaminated, but the infection brought in the bodies of the men and in their clothing and equipage was disseminated by flies and the epidemic continued until the coming of cool weather destroyed these pests which had inflicted greater loss upon the American soldiers than the arms of Spain.

The fact that the epidemic of typhoid fever at Knoxville disappeared with the approach of cool weather—at a time when typhoid fever is generally found to be most rife in civil practice—is to us a strong confirmation of our belief that flies had much to do with the dissemination of this infection.

Summary of deaths in the Second Division of the First Army Corps.

Commands.	Total deaths.	Deaths due to typhoid fever.
First Brigade.		
31st Michigan	27	16
160th Indiana	11	8
1st Georgia	10	9
	48	33
Second Brigade.		
158th Indiana	12	10
6th Ohio	21	19
1st West Virginia	15	12
	48	41
Third Brigade.		
1st Pennsylvania	14	12
14th Minnesota	11	10
2d Ohio	14	13
	39	35

Total deaths	135
Deaths due to typhoid fever	109
Percentage of deaths from typhoid to total deaths	80.7

CHAPTER III.

TYPHOID FEVER IN THE THIRD DIVISION OF THE FIRST ARMY CORPS.

Commands.—Fifth Pennsylvania, Twelfth Minnesota, First South Carolina, Eighth Massachusetts, Twenty-first Kansas, Twelfth New York, Second Missouri, First New Hampshire, and Ninth Pennsylvania.

GENERAL REMARKS.

All the regiments of this division excepting the First South Carolina arrived at Chickamauga Park, Ga., practically at the same time (May 20); all left about the same time (August 23–27), and all went to Lexington, Ky. The following table gives figures showing some of the most important facts concerning typhoid fever in the different regiments of this division:

Commands.	Date of first case.	Total number of cases.	Number of recognized cases.	Total deaths.	Deaths from typhoid.	Per cent of deaths among probable cases.	Per cent of deaths among recognized cases.
First Brigade.							
5th Pennsylvania	May 19	338	152	16	16	4.73	10.52
12th Minnesota	May 20	433	144	20	19	4.38	13.12
Second Brigade.							
8th Massachusetts	May 28	272	157	30	19	7.00	12.10
21st Kansas	May 21	294	95	23	21	7.14	22.10
12th New York	June 6	490	144	21	20	4.00	13.88
Third Brigade.							
2d Missouri	May 26	268	181	20	19	7.08	10.49
1st New Hampshire	May 24	297	213	32	30	10.00	14.13
9th Pennsylvania	May 31	334	155	28	26	7.78	16.77

Total number of cases of probable typhoid fever in the eight regiments	2,726
Total number of cases of recognized typhoid fever in the eight regiments	1,241
Total number of deaths in the eight regiments	189
Total number of deaths from typhoid fever in the eight regiments	170
Percentage of deaths among probable cases of typhoid fever	6.23
Percentage of deaths among recognized cases of typhoid fever	13.69
The mean strength of these eight regiments from May to September, as nearly as we can ascertain, was	10,329
Figuring on this basis we find the percentage of probable typhoid fever in these eight regiments to be	26.39

It was quite generally believed among medical officers at Chickamauga that the Second Division of this corps developed typhoid fever much later than the Third Division. As we have already learned, the Second Division obtained its water supply from wells and springs; the Third Division obtained its water supply principally from the pipes that distributed the water of Chickamauga Creek. Many army

medical officers believed that the Chickamauga Creek water became contaminated early in July, and that regiments supplied with that water developed typhoid fever much more prominently and rapidly than the other regiments did. In order to determine how much of truth there may have been in this general idea, we will tabulate the principal figures concerning typhoid fever in both of these divisions. In doing so we will omit the One hundred and sixtieth Indiana from the Second Division and the First South Carolina from the Third Division. This will make the mean strength of the two divisions practically the same. We omit these two regiments because both of them left Chickamauga much earlier than the other regiments. Omitting these two, all the regiments of the Second and Third Divisions reached Chickamauga within a few days (May 17–22), and all left within a few days (August 21–29) with the exception of the fact that the First Georgia did not reach Chickamauga until June 17. However, this regiment had been encamped at Griffin, Ga., and we will include the cases of typhoid fever developed in this regiment at that place.

Commands.	Date of first case.	Number of cases developed at Chickamauga.	Total number of cases.	Total deaths.	Deaths from typhoid.
SECOND DIVISION.					
First Brigade.					
31st Michigan	June 1	95	239	27	16
1st Georgia	June 6	86	120	10	9
Second Brigade.					
158th Indiana	June 6	95	128	12	10
6th Ohio	May 18	70	291	21	19
1st West Virginia	June 6	85	260	15	12
Third Brigade.					
1st Pennsylvania	May 12	129	222	14	12
14th Minnesota	May 27	114	286	11	10
2d Ohio	May 20	160	403	14	13
Total		834	1,949	124	101
THIRD DIVISION.					
First Brigade.					
5th Pennsylvania	May 19	182	338	16	16
12th Minnesota	May 20	320	433	20	19
Second Brigade.					
8th Massachusetts	May 28	55	272	30	19
21st Kansas	May 21	153	294	23	21
12th New York	June 6	197	490	21	20
Third Brigade.					
2d Missouri	May 26	149	268	20	19
1st New Hampshire	May 24	261	297	32	30
9th Pennsylvania	May 31	287	334	28	26
Total		1,604	2,726	190	170

Total number of cases of probable typhoid fever in eight regiments of the Second Division	1,949	
Total number of cases of probable typhoid fever in eight regiments of the Third Division	2,726	
Excess of cases of probable typhoid fever in the Third Division over those in the Second Division		777
Total number of cases of probable typhoid fever developed in eight regiments of the Second Division at Chickamauga	834	
Total number of cases of probable typhoid fever developed in eight regiments of the Third Division at Chickamauga	1,604	
Excess of cases of probable typhoid fever developed at Chickamauga in the Third Division over those developed in the Second Division		770
Total number of deaths in eight regiments of the Second Division	124	
Total number of deaths in eight regiments of the Third Division	190	
Excess of deaths in the Third Division over those in the Second Division		66
Total number of deaths from typhoid fever in eight regiments of the Second Division	101	
Total number of deaths from typhoid fever in eight regiments of the Third Division	170	
Excess of deaths from typhoid fever in the Third Division over those in the Second Division		69
Percentage of deaths among probable cases of typhoid fever in the Second Division		5.17
Percentage of deaths among probable cases of typhoid fever in the Third Division		6.23

We certainly must conclude from the above-given figures that the general idea prevalent among medical officers at Chickamauga that typhoid fever was much more prevalent in the Third Division of the First Army Corps than in the Second Division of the same corps is correct. Typhoid fever diffused more rapidly and more widely through the Third Division than it did through the Second Division. Whether or not the greater prevalence of typhoid fever in the Third Division was due to the fact that the regiments of this division used Chickamauga Creek water we will not at present attempt to determine. We will leave the discussion of this subject until we have studied typhoid fever in the Third Corps.

Summary of deaths in the Third Division of the First Army Corps.

Commands.	Total deaths.	Deaths due to typhoid fever.
First Brigade.		
5th Pennsylvania	16	16
12th Minnesota	20	19
1st South Carolina	20	10
Total	56	45
Second Brigade.		
8th Massachusetts	30	19
21st Kansas	23	21
12th New York	21	20
Total	74	60
Third Brigade.		
2d Missouri	20	19
1st New Hampshire	32	30
9th Pennsylvania	28	26
Total	80	75

Total deaths	210
Deaths due to typhoid fever	180
Percentage of deaths from typhoid to total deaths	85.71

In comparing the extent to which typhoid fever prevailed in the different organizations of this corps, one question that very naturally arises is: Did the regiments that remained at Chickamauga suffer more or less from typhoid fever than those that left Chickamauga earlier in the season? In order to study this question we will divide the regiments of this corps into two groups. The first group will contain those regiments that left Chickamauga before August 3, 1898. The second group will contain those regiments which left Chickamauga subsequent to August 3, 1898. We will endeavor to ascertain which of these groups of regiments suffered more severely from typhoid fever, and which had the greater death rate. In making this comparison we will have to depend upon the total number of deaths and the deaths attributed to typhoid fever.

FIRST GROUP.

	Total deaths.	Deaths from typhoid.	Per cent of deaths among probable cases.	Per cent of deaths among recognized cases.
1st Kentucky	28	18	6.87	20.45
3d Wisconsin	36	24	6.34	22.41
5th Illinois	16	8	6.40	7.08
4th Ohio	26	19		
3d Illinois	44	25	4.57	16.77
4th Pennsylvania	35	24		
16th Pennsylvania	40	34		
2d Wisconsin	41	27	8.20	23.89
3d Kentucky	17	11	5.02	
160th Indiana	11	8	3.58	17.02
1st South Carolina	20	10		

SECOND GROUP.

	Total deaths.	Death from typhoid.	Per cent of deaths among probable cases.	Per cent of deaths among recognized cases.
31st Michigan	27	16	6.69	18.60
1st Georgia	10	9	7.50	25.00
158th Indiana	12	10	7.81	20.40
6th Ohio	21	19	6.52	12.83
1st West Virginia	15	12	4.61	11.32
1st Pennsylvania	14	12	5.40	7.10
14th Minnesota	11	10	3.49	6.85
2d Ohio	14	13	3.22	6.77
5th Pennsylvania	16	16	4.73	10.52
12th Minnesota	20	19	4.38	13.19
8th Massachusetts	30	19	7.00	12.10
21st Kansas	23	21	7.14	22.10
12th New York	21	20	4.00	13.88
2d Missouri	20	19	7.08	10.49
1st New Hampshire	32	30	10.00	14.13
9th Pennsylvania	28	26	7.78	16.77

Eleven regiments in the first group lost from all causes 314
These 11 regiments had an aggregate strength when they left Chickamauga of .. 13,814
Percentage of deaths from all causes in the 11 regiments that left Chickamauga early 2.26
Sixteen regiments in the second group lost from all causes 314
These 16 regiments had an aggregate strength when they left Chickamauga of .. 20,334
Percentage of deaths from all causes in the 16 regiments of the second group, which left Chickamauga later 1.54

It will be seen from these figures that so far as loss by death from all causes goes, these two groups differed, the loss being greater in the regiments that left Chickamauga early.

Eleven regiments in the first group lost by death from typhoid fever 208
Percentage of deaths from typhoid fever in the 11 regiments that left Chickamauga early 1.50
Sixteen regiments in the second group lost by death from typhoid fever 271
Percentage of deaths from typhoid fever in the 16 regiments that remained longer at Chickamauga 1.33

It will be seen from these figures that while there is a marked difference in the percentage of total deaths in these two groups, the percentages of deaths from typhoid fever differ less.

Seven regiments out of the first group had among the probable cases of typhoid fever an average death rate of ..... per cent .. 4.39
Sixteen regiments in the second group had among the probable cases of typhoid fever an average death rate of ..... per cent .. 6.03

These figures, in our opinion, furnish additional evidence to our claim that we have not overestimated the number of cases of typhoid fever.

We will next inquire whether or not the regiments that went to Porto Rico suffered more severely by deaths from all causes than did the regiments that remained in this country. The following figures bear upon this inquiry:

Seven regiments of this corps that went to Porto Rico had a total loss by death of 250
Aggregate strength of these regiments on leaving Chickamauga 8,750
Percentage of deaths from all causes among the regiments that went to Porto Rico 2.85
Percentage of deaths from all causes among those regiments that remained at Chickamauga 1.51

It will be seen from these figures that the loss of life was materially increased by sending these troops to Porto Rico.

The following table gives figures showing the most important facts concerning typhoid fever in the First Army Corps:

NOTE.—The regiments marked * went to Porto Rico. For these regiments the "Total deaths" and "Deaths from typhoid" are those which occurred at Chickamauga.

	Date of first case.	Total number of cases.	Number of recognized cases.	Total deaths.	Deaths from typhoid.	Per cent of deaths among probable cases.	Per cent of deaths among recognized cases.
FIRST DIVISION.							
First Brigade.							
*1st Kentucky	June 19	262	86	13	6	2.29	6.81
3d Wisconsin	May 24	378	107	14	9	2.38	8.41
5th Illinois	May 16	125	113	16	8	6.40	7.08
Second Brigade.							
*4th Ohio	May 17			11	7		
*3d Illinois	do	546	149	24	11	2.01	7.38
*4th Pennsylvania	June 1			21	14		
Third Brigade.							
*16th Pennsylvania	May 8			15	13		
2d Wisconsin	May 11	329	113	32	23	7	20.3
3d Kentucky	June 9	219		17	11	5.02	
SECOND DIVISION.							
First Brigade.							
31st Michigan	June 1	239	86	27	16	6.69	18.60
160th Indiana	July 4	223	47	11	8	3.58	17.02
1st Georgia	June 6	120	36	10	9	7.50	25
Second Brigade.							
158th Indiana	June 6	128	49	12	10	7.81	20.40
6th Ohio	May 18	291	148	21	19	6.52	12.83
1st West Virginia	June 6	260	106	15	12	4.61	11.31
Third Brigade.							
1st Pennsylvania	May 12	222	169	14	12	5.40	7.10
14th Minnesota	May 27	286	146	11	10	3.49	6.85
2d Ohio	May 20	403	192	14	13	3.22	6.77
THIRD DIVISION.							
First Brigade.							
5th Pennsylvania	May 19	338	152	16	16	4.73	10.52
12th Minnesota	May 20	433	144	20	19	4.38	13.19
1st South Carolina				20	10		
Second Brigade.							
8th Massachusetts	May 28	272	157	30	19	7	12.10
21st Kansas	May 21	294	95	23	21	7.14	22.10
12th New York	June 6	490	144	21	20	4	13.88
Third Brigade.							
2d Missouri	May 26	268	181	20	19	7.08	10.49
1st New Hampshire	May 24	297	213	32	30	10	14.13
9th Pennsylvania	May 31	334	155	28	26	7.78	16.77

Total number of cases of probable typhoid fever in this corps, excluding the 7 regiments that went to Porto Rico and the First South Carolina 5,242

Aggregate strength of these 19 regiments 24,235

Percentage of typhoid fever among these 19 regiments 21.62

Total number of deaths from typhoid fever in these 19 regiments 298

Percentage of deaths among probable cases of typhoid fever 5.68

This percentage is too low for two reasons: First, it is certain that we have not been able to obtain a complete list of deaths; second, in the list of deaths as we have given it several cases attributed to other causes were undoubtedly due to typhoid fever.

In these 19 regiments the number of recognized cases of typhoid fever was	2,552
Percentage of deaths among recognized cases of typhoid fever	11.67

Of course this last statement can not be correct, because all the deaths from typhoid fever did not occur among the recognized cases. From these figures we have no hesitancy in concluding that our list of probable typhoid fevers more nearly represents the actual number than does the list of recognized cases.

Summary of deaths in the First Army Corps.

Commands.	Total deaths.	Deaths due to typhoid fever.	Percentage of deaths from typhoid to total deaths.
First Division	283	190	67.49
Second Division	135	109	80.74
Third Division	210	180	85.71
Total	628	479	76.27

In this tabular statement of the First Army Corps are included seven regiments of the First Division, which started early for Porto Rico, and the First South Carolina Regiment (Third Division). The records of these eight regiments are very incomplete, and they have therefore been omitted from the following general summary of the statistics of the board:

Table showing for certain regiments of the First Army Corps assembled at Chickamauga the mortality and morbidity from typhoid fever.

Regiments.	Mean strength.	Cases of typhoid fever.		Deaths from typhoid fever.	Deaths from all diseases.
		Certain.	Certain and probable.		
FIRST DIVISION.					
5th Illinois	1,296	113	125	8	16
3d Kentucky	1,293	219	219	11	17
Total	2,589	332	344	19	33
SECOND DIVISION.					
31st Michigan	1,290	86	239	16	27
160th Indiana	1,312	47	223	8	11
1st Georgia	1,212	36	120	9	10
158th Indiana	1,288	49	128	10	12
6th Ohio	1,299	148	291	19	21
1st West Virginia	1,298	106	260	12	15
1st Pennsylvania	1,071	169	222	12	14
14th Minnesota	1,277	146	286	10	11
2d Ohio	1,297	192	403	13	14
Total	11,344	979	2,172	109	135

Table showing for certain regiments of the First Army Corps, etc.—Continued.

Regiments.	Mean strength.	Cases of typhoid fever.		Deaths from typhoid fever.	Deaths from all diseases.
		Certain.	Certain and probable.		
THIRD DIVISION.					
5th Pennsylvania	1,291	152	338	16	16
12th Minnesota	1,299	144	433	19	20
8th Massachusetts	1,317	157	272	19	30
21st Kansas	1,264	95	294	21	23
12th New York	1,302	144	490	20	21
3d Missouri	1,269	181	268	19	20
1st New Hampshire	1,269	213	297	30	32
9th Pennsylvania	1,291	155	334	26	28
Total	10,302	1,241	2,726	170	190
CAVALRY BRIGADE.					
3d U. S. Volunteers	1,013	103	270	13	15
1st Illinois	1,299	68	220	16	17
1st Ohio Volunteers	833	189	189	7	7
Total	3,145	360	679	36	39
Total, First Army Corps	27,380	2,912	5,921	334	397

Regiments.	Deaths from typhoid fever in 100 cases of—		Percentage of deaths from typhoid to all diseases.	Morbidity of typhoid fever in 1,000 mean strength—		Deaths from typhoid fever in 1,000 of mean strength.
	Certain typhoid.	Certain and probable.		For certain cases of typhoid.	For certain and probable cases of typhoid.	
FIRST DIVISION.						
5th Illinois	7.07	6.04	50.00	87.19	96.45	6.17
3d Kentucky	5.02	5.02	64.70	170.69	170.69	8.50
Total	5.72	5.52	57.57	128.83	132.86	7.33
SECOND DIVISION.						
31st Michigan	18.60	6.69	59.25	66.66	185.27	12.40
160th Indiana	17.02	3.58	72.72	35.82	169.96	6.09
1st Georgia	25.00	7.50	90.00	29.70	99.00	7.42
158th Indiana	20.40	7.81	83.33	38.04	99.37	7.76
6th Ohio	12.83	6.52	90.47	113.93	224.01	14.62
1st West Virginia	11.32	4.61	80.00	81.66	200.30	9.24
1st Pennsylvania	7.10	5.40	85.71	157.79	207.28	11.20
14th Minnesota	6.84	3.49	90.90	114.33	223.96	7.83
2d Ohio	6.77	3.22	92.85	148.03	310.71	10.02
Total	11.13	5.01	80.74	86.30	191.46	9 60
THIRD DIVISION.						
5th Pennsylvania	10.52	4.73	100.00	117.73	261.81	12.39
12th Minnesota	13.12	4.38	95.00	110.85	333.33	14.64
8th Massachusetts	12.10	6.98	63.33	119.21	206.53	14.42
21st Kansas	22.10	7.14	91.30	75.15	232.59	16.81
12th New York	13.88	4.08	95.23	110.59	376.34	15.36
3d Missouri	10.49	7.08	95.00	142.63	211.18	14.97
1st New Hampshire	14.08	10.10	93.75	167.84	234.04	23.64
9th Pennsylvania	16.77	7.78	92.85	120.06	258.71	20.13
Total	13.69	6.23	89.47	120.46	264.60	16.50
CAVALRY BRIGADE.						
3d U. S. Volunteers	12.62	4.81	86.66	101.67	266.53	12.83
1st Illinois	23.52	7.27	94.11	52.34	169.36	12.31
1st Ohio Volunteers	3.70	3.70	100.00	226.88	226.88	8.40
Total	10.00	5.30	92.30	114.46	215.89	11.44
Total, First Army Corps	11.46	5.64	84.13	106.35	216.25	12.19

CHAPTER IV.

TYPHOID FEVER IN THE FIRST DIVISION, THIRD ARMY CORPS.

Commands.—Fourteenth New York, First Missouri, Fifth Maryland, Second Nebraska, Second New York, First District of Columbia (no data), Third Tennessee, First Vermont, and Eighth New York.

GENERAL REMARKS.

Our knowledge concerning the conditions existing among the regiments of this division at Chickamauga is meager and fragmentary. When we reached Chickamauga on our tour of inspection all the regiments of this division had departed. We obtained the testimony of Maj. Guy L. Edie, who for some time acted as sanitary inspector for this division. To this testimony we are indebted for the following information. Major Edie reached Chickamauga August 3, 1898, and began immediately to inspect these regiments. When asked as to the condition found in this inspection, he made the following statement:

I found that nearly all the companies had kitchen sinks within a few feet of the kitchens. These sinks consisted of shallow pits which when filled were covered with earth. Into these, kitchen refuse and slops were thrown. The privy vaults were dug to the rear, some of them at the proper distance but very shallow and wide, and the contents were imperfectly covered. Some of these pits were not more than 2 feet deep. Neither earth nor lime had been thrown upon the contents. They were in a very filthy condition and contained myriads of flies. I found the camp of the Third U. S. Cavalry very bad. I went through the companies and told the captains that they would probably have a great deal of sickness. I rode through the woods adjoining this camp and saw at that time 14 men defecating in the woods. There were probably more, for there was a long stretch of the woods. With the exception of two regiments the locations of all the organizations of this division were pretty, but the sinks were in a miserable condition. Most of these regiments had remained in the same location since coming to this place. Efforts had been made, as I found out afterwards, to change the sites of the camps. I advised that the regiments be moved out of the woods into the sunlit fields, but was told that a man had a lease of these fields and that time would be necessary in order to get a permit to occupy them. Later, lime was obtained, and I instructed each regimental and brigade surgeon to see that each regiment had a barrel of lime each day and that it be used freely for both kitchen and company sinks. I also advised that the kitchen refuse be hauled away and that the company sinks be dug deeper and the contents be covered with earth and lime each day. At that time there was not sufficient tentage for the sick, and some of them were compelled to lie under flies. A number of the hospital tents did not have floors. The quartermaster was directed to make requisition for the lumber needed for flooring and for hospital tents. I brought these requisitions over to headquarters and had them approved. I then went and saw the quartermaster, and very shortly afterwards a sufficient quanity of hospital tents and lumber for flooring were furnished for the division hospital.

I recommended that the men be compelled to boil the water taken from the hydrant, and an order to this effect was issued. However, I believe that this order was not fully obeyed. Men frequently drank from the hydrants, and at two

reviews I saw men filling their canteens from the hydrants. This water was obtained from Chickamauga Creek. A number of the regiments, however, hauled their water from springs outside the park, principally from Blue Spring and Park Spring. There was one driven well in this division, and individually the men used water from this well. This was especially true of the ambulance corps and of the Eighth New York Volunteer Infantry. The water obtained from Blue Spring was cloudy. The water obtained from the pipes was abundant in quantity. but of suspicious quality. As to obtaining water from the springs, there were not enough barrels for storing this water until latterly, when a sufficient supply of barrels was obtained.

Many huckster wagons were driven through the camps, and milk from these was generally sold to the soldiers. This milk was of doubtful quality. The milk for the hospitals was sent from Biltmore, N. C., and we received about 200 gallons of this each day. This milk was supposed to be good. An order was issued to keep venders of milk outside the limits of the division.

The regimental and brigade officers were requested to have the fruits and melons offered for sale among the men inspected. and to permit the sale of only those that were apparently good.

When asked whether or not he had formed any opinion concerning the source and the manner by which typhoid fever was spread throughout this division, Major Edie made the following statement:

I thought that the piped water supply was infected, and there was ample opportunity for the food around the kitchens to get infected by the flies. The fecal matter in the pits was not covered, as I have stated. The cook at the division hospital called my attention to the fact that when they were using lime freely around the sinks the flies alighting upon the food had their feet covered with lime. The great increase in typhoid fever was immediately after heavy rains. I should say about ten days or two weeks after heavy rains. We had some typhoid fever before that time, but the great influx of typhoid cases came after the heavy rains. There were also numerous wet-weather springs in the hollows, and many of the companies used this water. I saw soldiers drinking from these springs and cautioned them against it. They thought that it was good water, but it was nothing but a wet-weather spring.

In regard to the hospital of the First Division of the Third Army Corps, Lieut. Col. A. A. Woodhull, in a report to the Surgeon-General under date of August 7, 1898, makes the following statement:

At the time of my inspection, July 27, the hospital control was just being assumed by a newly arrived officer, who could not be regarded as responsible for its defects nor be credited with its advantages. The staff consists of 5 medical officers, and the enlisted force was 95 noncommissioned officers and privates of the Hospital Corps. The hospital consists of 30 hospital tents for all purposes, containing at this date 179 patients. The tents are too crowded. containing 8 patients apiece, and they have had 10. There is insufficient space between the wards, the grounds are not adequately ditched, and the approach to the patients' sinks is very poor. The sinks themselves are very bad. The hospital is not divided into brigades. The Red Cross supplies about one-half of the clothing and the bedding. The floors that have been supplied the tents were furnished by regimental means. The hospital fund started with $50, and there was $48 at the end of the month, but considerable expenditures had been made by emergency funds supplied by the regiments. Very serious complaints are made as to the inadequacy of the medical supplies. No atropine is on hand, and the salol has been bought by private means. The chloroform supplied from the 1st to 10th of June was regarded as inert, although this might depend on the inexperience of

the administrator in open-air work, but the bottles contained a small part of the marked contents. Chocolate-coated quinine tablets in stock, Parke, Davis & Co., tablet 125 (563360 in red), are insoluble and found in the stools. I am informed in Washington that this is not supplied by the Medical Department. It was evidently regarded there as part of the regular supplies. The food as a whole is good, and the special diet kitchen was very neat and appeared excellent. Two of a case of twelve sides of bacon then on hand were bad, and I personally observed the maggots in them. There was only one very small coffee mill, apparently belonging to a mess chest, for the whole hospital, and one man was employed all day in grinding coffee. The average duration of treatment, excluding the typhoid cases, is stated at three or four days. Cases are transferred to Leiter and to McPherson general hospitals. Fifty men are employed as nurses and are on duty from twelve to eighteen hours continuously, day by day. As far as observed, all the hospital cases of this division were taken into the hospital.

In looking over the list of cases of probable typhoid fever in this division one is at once struck by the much greater number of cases in the Eighth New York than in any other regiment of the division. Since all of these regiments used the Chickamauga Creek, we must conclude that the great prevalence of typhoid fever in the Eighth New York must have been due to some special local condition and that water infection could not have been the most important factor in the spread of typhoid fever in this division. While we did not reach Chickamauga in time to inspect the regiments of this division, the general statement was made to us that the camp of the Eighth New York was especially filthy. Whether or not the men of this regiment received the typhoid infection from the water of the driven well which they used or from wet-weather springs we can not say.

The following figures give the principal facts concerning typhoid fever in this division:

Commands.	Date of first case.	Total number of cases.	Number of recognized cases.	Total deaths.	Deaths from typhoid.	Per cent of deaths among probable cases.	Per cent of deaths among recognized cases.
First Brigade.							
14th New York	May 23	233	95	31	24	10.30	25.26
1st Missouri	May 31	216	46	14	11	5.09	23.91
6th Maryland	June 25	250	147	18	17	6.80	11.56
Second Brigade.							
2d Nebraska	May 26	167	56	28	22	13.17	39.28
2d New York	June 1	161	46	31	30	18.63	65.21
1st District of Columbia							
Third Brigade.							
3d Tennessee	June 9	123	61	19	12	9.75	19.67
1st Vermont	May 26	278	84	56	22	7.91	26.19
8th New York	June 24	425	190	23	22	5.17	11.57

Total number of cases of probable typhoid fever in the 8 regiments of this division 1,853
Total number of deaths from typhoid in the 8 regiments 160
Percentage of deaths among probable cases of typhoid fever 8.63
Total number of cases of recognized typhoid fever in the 8 regiments of this division 725
Percentage of deaths among recognized cases of typhoid fever 22.06

Summary of deaths in the First Division of the Third Army Corps.

Commands.	Total deaths.	Deaths due to typhoid fever.
First Brigade.		
14th New York	31	24
1st Missouri	14	11
5th Maryland	18	17
	63	52
Second Brigade.		
2d Nebraska	28	22
2d New York	31	30
1st District of Columbia	25	14
	84	66
Third Brigade.		
3d Tennessee	19	12
1st Vermont	26	22
8th New York	23	22
	68	56

Total deaths	215
Deaths due to typhoid fever	174
Percentage of deaths from typhoid to total deaths	80.93

CHAPTER V.

TYPHOID FEVER IN THE SECOND DIVISION OF THE THIRD ARMY CORPS.

Commands.—Second Kentucky, Ninth New York, First Arkansas, Fifth Missouri, Second Arkansas, Sixty-ninth New York, First Maine. Fifty-second Iowa, and First Mississippi.

GENERAL REMARKS.

When we reached Chickamauga Park on our round of inspection (September 10, 1898) all the regiments of this division with the exception of the Second Kentucky and the Ninth New York had already departed from the park. We have already given a statement of the condition in which we found the two remaining regiments. For the following information concerning the division as a whole we are indebted to the testimony of Maj. James M. Jenne, chief surgeon of this division. Major Jenne reached Chickamauga Park June 11, and acted as medical inspector until July 16, when he was made chief surgeon of the division. All the regiments were on the ground when Major Jenne arrived. The First Arkansas was located on very low ground, while directly above this regiment were the Ninth New York and the Second Kentucky. The First Arkansas was partially protected from the drainage of the other regiments by a shoulder of the hill that projected behind the officers' quarters. The Second Brigade was situated on the same level, but farther south, with an intervening creek which flowed only after rains. Overlapping the Second Brigade and extending beyond one of its flanks on to higher ground was the First Maine. The Fifty-second Iowa was still farther south and situated

upon a rocky shoulder of ground quite elevated in some portions and wholly denuded of soil. In this regiment the tents were pitched upon the rocks, and the guy ropes were held in position by piles of rocks. The Mississippi regiment was somewhat farther south and upon quite low ground in dense shade. A little stream coming from the heights above passed through this camp. This stream originated in the Second Brigade. It was only about 60 paces from the kitchens of the Fifty-second Iowa and the nearest line officer's tent of the Third Tennessee, which belonged to the Third Brigade of the First Division of the Third Army Corps. South of the Mississippi regiment was the Alexandria road, and on the west of this a small stream and an open field. On account of the location, the sinks of the Mississippi regiment could not be placed over 30 paces from their company kitchens and about the same distance from other regiments. Major Jenne stated that he remembered going to the camp of the First Mississippi and pacing the ground from the kitchen to the sink, which he found to be 30 paces, and the same distance from the sinks of the Mississippi regiment to the line officers' tents of the Third Tennessee. In locating the sinks of the First Mississippi it was impossible to go farther south or west on account of the little stream, which rapidly filled after rains, overflowed its banks, and flooded the woods for some distance. If the sinks had been dug to the west in the open field they would have been submerged at times when the stream overflowed. It seemed necessary to locate the sinks where they were placed. It will be seen from this that these regiments were quite crowded, that they were all located in the woods, and that the drainage from some of them passed through the sites of others. The First Arkansas received more or less of the drainage from the Ninth New York and the Second Kentucky. The Ninth New York received in part at least the drainage of the Second Kentucky.

When Major Jenne reached Chickamauga all of the regiments were using Chickamauga Creek water, distributed through the commands by means of pipes. Later, this water becoming suspicious, some of these regiments began to draw water from springs, especially from Blue Spring and Crawfish Spring. Water distributed through the pipes was turbid and warm, inasmuch as the pipes were above the ground. Attempts were made, especially in the First Maine and the Fifty-second Iowa, to boil all the drinking water, but according to Major Jenne the supply of boiled water was at no time sufficient and the men daily took water from other sources. There was only one driven well near the regiments of this division, and Major Jenne is of the opinion that the water from this was not at all times used. After the medical officers became suspicious of the Chickamauga Creek water and attempted to substitute spring water for it, there was a general shortage of drinking water on account of there being an insufficient number of barrels in which it could be transported. On account of this insufficient supply of water from the springs, men

continued to drink more or less of the piped water and doubtless drank at times from wet-weather springs.

An attempt was made to filter the water for the entire division. Each regiment was furnished with eleven pairs of Maignem and Berkefeld filters. In the First Brigade these filters were brought together at one place and an attempt was made to filter enough drinking water for the whole brigade. This attempt to filter the water did not prove successful. The Maignem filters soon became obstructed and many of the Berkefeld filters were broken. The filtering plant for the First Brigade was in charge of a detail from the Ninth New York, and within a few days so many filters were disabled or broken that the attempt was given up and pronounced a failure. In the Second and Third brigades each regiment attempted to filter its own water, but in these also the same result was reached—the filters became clogged, many were broken, and the attempt was discontinued. At this place we wish to state that, in our opinion, for troops in the field all attempts made to filter the water by means of the Maignem and Berkefeld filters were failures. We do not consider these filters at all adapted to this purpose. In permanent garrisons, where the filters can be attached to hydrants, they are undoubtedly of service, but in the field, where it frequently happens that water containing suspended matter must be filtered, these filters, together or singly, have not been a success and will not be a sucess. The national encampments at Chickamauga and at Camp Meade were strewn with broken filters which represented a large and useless expenditure.

Major Jenne stated that throughout this division there were numerous wet-weather springs from which the men frequently drank. It is more than likely that these springs account very largely for the large number of cases and the excessive mortality from typhoid fever in this division. As has been already stated, some of the regiments were located upon rocky knolls. The rains falling upon these sites washed infected matter under the rocks, carried it some distance under the surface of the ground, and broke out lower down the hillside, often within other regimental encampments as wet-weather springs, from which the men drank to a greater or less extent.

When asked his opinion concerning the origin and spread of typhoid fever in this division, Major Jenne made the following statement:

My belief is that the Mississippi regiment came to the Park infected with typhoid fever. From the sinks of this regiment the creek that flowed near by became contaminated. This creek empties into Chickamauga Creek only a few feet below the intake of the general water supply distributed to the regiments. I believe that in this way the general water supply became contaminated and typhoid fever was spread throughout the division.

When asked if he believed that the disease was spread by means of flies, he replied as follows:

Yes; I have no doubt that this was one of the most fruitful means of the spread of the disease. The sinks in some of the regiments of this division, certainly during the wet season, were almost constantly filled with water. A great deal has been

stated about the sinks not being properly ditched. This was true in some instances, but had all the sinks been properly ditched, they would have still filled with water from the bottom and the sides. When a sink was dug soon after a shower the water would flow into it like a spring. I have seen this time and time again; I have seen men digging sinks and the water flowing in from the sides and bottoms while they were digging. Water did not soak into all the sinks. In digging one on the side of a hill it would be likely to fill with water, while another dug on the level might remain dry. There were some sinks that gave me a great deal of trouble. I used a solution of bichloride of mercury and plenty of lime in them. When they were nearly full of water and fecal matter I put cord wood across them and placed straw and brush on the wood and heaped earth over them. If an attempt had been made to fill these sinks in the ordinary way, the earth thrown in would have caused the contents to overflow. Indeed, it is quite out of the question to throw earth into these sinks, because it displaces the water. It was the practice to put staw in them from the corrals and burn them out. Some of the sinks were situated on sharp inclines and during rains they would fill, overflow, and run down the hillsides, sometimes through the camp. There were three regiments situated one after the other passing down the hill, so that whatever wash there was from their sinks and the regiment above came to them. These were the First Mississippi, the Fifty-second Iowa, and the First Maine. Of these three regiments the Fifty-second Iowa occupied the highest ground, and the flow from this site was in one direction toward the First Maine and in the other direction toward the First Mississippi. The Third Tennessee was farther up the hill. All of these regiments were closely crowded together.

In regard to the hospital of this divison Lieutenant-Colonel Woodhull, in his report already referred to, makes the following statement:

Nearly, if not all, of the regiments in this division maintain regimental hospitals. For instance, the Ninth New York has from 6 to 8 men in a local hospital out of 60 supposed to be in quarters. In the division hospital are 33. The regiment has had about 30 cases of typhoid, but the proportion of malarial cases is not large. First Arkansas has 37 in hospital and 85 in quarters. When examined there was a small regimental hospital maintained by individual subscription, in which were 3 cases of dysentery alleged to have been returned from the division hospital. First Maine has 7 men in the regimental hospital. Of the 42 officers, 7, or 16.67 per cent, are sick, all with typhoid fever.

The hospital of this division (Major Bradbury, First Maine, in charge) consists of 37 hospital, 8 conical, and 6 common tents, containing 285 cots and 250 patients. Eight medical officers are present for duty, with 6 stewards and 138 privates. Of the latter, 45 were men of the line detailed from regiments. To this date, August 7, 1898, 1,190 patients have passed through the hospital, and 56 typhoid cases were present. Were all the men in the division who should be in hospital present it would be overcrowded, as it has been when men were at times literally upon the ground, and at other times medical officers have given up their own accommodations to them. Sometimes typhoid patients are returned to their regiments for convalescence in order to make room. Speaking generally the condition of the hospital is very good. The streets are broad and well policed; the general police is excellent; the ordinary wards are very good, but the typhoid ward is too crowded and formerly was still more so when the cots touched each other.

There is great difficulty in disinfecting the bedding. The hospital is brigaded but not the attendants, and there would be difficulty were the command suddenly broken up. There are several brigade surgeons at this hospital and it is plain that they do not regard that as their proper sphere. The records are well kept, but great difficulty is experienced in obtaining supplies. This seems to be partly technical and partly from insufficient stores. I examined the record of a requisi-

tion made on the 1st, acted on on the 13th, 17th, and 19th, and on the 22d filled in part. I saw another where two articles were supplied out of seventeen authorized. The hospital finds it practically impossible to get intestinal antiseptics, such as salol, or strychnia, or subgallate of bismuth. It is very largely dependent upon regimental and Red Cross funds, and a case of boxes to hold regimental supplies has been arranged to stimulate regimental interest, which is quite foreign to the principle of these organizations. The Red Cross supplies 1,500 pounds of ice daily; milk, food, comforts, and some absolute necessities, as medicines themselves.

The following figures give the most important facts concerning typhoid fever in this division:

Commands.	Date of first case.	Total number of cases.	Total number of recognized cases.	Total deaths.	Deaths from typhoid.	Per cent of deaths among probable cases.	Per cent of deaths among recognized cases.
First Brigade.							
2d Kentucky	June 26	286	87	30	28	9.79	32.18
9th New York	June 10	323	139	46	46	14.24	33.09
1st Arkansas	June 2	228	83	23	19	8.33	22.89
Second Brigade.							
5th Missouri	June 6	212	51	16	14	6.60	27.45
2d Arkansas	June 4	287	95	26	17	5.92	17.89
69th New York	June 12	299	191	25	23	7.69	12.04
Third Brigade.							
1st Maine	June 25	188	88	45	45	23.93	51.13
52d Iowa	June 8	345	184	37	36	10.43	19.56
1st Mississippi	June 1	397	98	33	29	7.30	29.59

Total number of cases of typhoid fever in the nine regiments of this division 2,565
Total number of deaths from typhoid fever in the nine regiments of this division 257
Percentage of deaths among probable cases of typhoid fever 10.02
Total number of cases of recognized typhoid fever in the nine regiments of this division 1,016
Percentage of deaths among recognized cases of typhoid fever 25.29

Summary of deaths in the Second Division of the Third Army Corps.

Commands.	Total deaths.	Deaths due to typhoid fever.
First Brigade.		
2d Kentucky	30	28
9th New York	46	46
1st Arkansas	23	19
Total	99	93
Second Brigade.		
5th Missouri	16	14
2d Arkansas	26	17
69th New York	25	23
Total	67	54
Third Brigade.		
1st Maine	45	45
52d Iowa	37	36
1st Mississippi	33	29
Total	115	110

Total deaths 281
Deaths due to typhoid fever 257
Percentage of deaths from typhoid to total deaths 91.45

Colonel Hoff, chief surgeon of this corps, has furnished us with considerable valuable information concerning sickness in it. Colonel Hoff reported for duty at Chickamauga Park May 25, 1898, and remained with this corps during its stay there. When asked to give his opinion concerning the introduction of typhoid fever in this corps, Colonel Hoff responded as follows:

Typhoid fever was brought in in the very beginning with the troops. I speak now particularly of the Third Corps with the history of which I am familiar from the date of its organization. Three regiments joined the Second Division of the Third Corps about the latter part of May or early in June, and these regiments came on the ground with what was practically a disabling sick list. These three regiments were the First Mississippi and the First and Second Arkansas. The record of the First Mississippi begins on the 12th of June, and total of sick reported for that day was 64. This number did not include all of those actually sick. There was a large number in the regiment who were sick, but who were not reported at that time. You will see (referring to a chart showing the curve of sickness in this regiment) as we go on we come to a very remarkable upshoot on the 30th day of June. This remarkable upshoot is due to the fact that that regiment was vaccinated at this time. There were 100 or more men suffering from the effects of vaccination, so this upward move of the curve must be regarded as only an incident. It will be seen that this upward turn reached its maximum on July 2. After this there was a gradual subsidence until the sick report went down to about what it was in the beginning, showing 85 men on the sick report on the 7th day of July. From the latter date on the sick list increased, as you see, with considerable rapidity, reaching the maximum on August 20, on which date the total on sick call numbered 210. From August 20 to September 9, when the First Mississippi left Lauderdale, the sick curve declined. This is in part due to the fact that men were sent home on sick furlough and were not carried on the sick report. It does not necessarily indicate diminished sickness. The Arkansas regiments came into this camp in practically the same condition as did the Mississippi regiment.

It should be understood that in the above statement Colonel Hoff was speaking of total sickness and not of typhoid fever especially. He convinced us that these three regiments came to Chickamauga with a high sick list and continued in this condition throughout their stay. It will be seen by reference to the tables already given that of the regiments of the Second Division of this corps (excluding the Sixty-ninth New York, which remained at Chickamauga Park for only a few days) all except the Second Kentucky and the First Maine reached Chickamauga Park infected with typhoid fever, while of those of the First Division (excluding the Fifth Maryland, which remained at Chickamauga Park for only a few days) all reached the park infected with typhoid fever with the exception of the Eighth New York.

Continuing his testimony, Major Hoff stated:

The Fifty-second Iowa and the First Maine reached the park in excellent condition. Going over the First Division, the Second Nebraska, Second Missouri, and Fourteenth New York came in excellent shape. The Eighth New York had a doubtful record so far as is indicated by total sickness from the very beginning. Typhoid fever gradually spread from the infected regiments and soon there were

cases in every regiment of the corps. By the middle of July or earlier all regiments were reporting a few cases of typhoid fever, but it could be called epidemic only in the three regiments mentioned (First Mississippi, First and Second Arkansas). In most of the regiments at that time typhoid fever was scarcely recognized, most of the cases being designated as "malaria." Up to the middle of August, possibly later, I believe that the infection was spread by means of flies. I believe the water supply became infected about the latter part of July, and from that time on there was a decided rise until it culminated about August 20.

Colonel Hoff believed that the general water supply taken from Chickamauga Creek became contaminated by the drainage from the camps, but that water contamination was not confined to this source. He stated:

I thought that every spring and every well, or almost all, in the park must have partaken of the infection. This is only an opinion, but the fact that we had an extraordinary and widespread morbidity leads to the inference that there must have been some common cause.

When asked about the first case of typhoid fever, Colonel Hoff stated:

The first case of typhoid fever that was diagnosticated appeared in the Second Division hospital about June 15. It appeared about the time when the cases began to be carefully investigated. The hospital opened about June 10, but it was not in running order until about June 15, and I have no doubt that had a careful investigation been made earlier cases of typhoid fever would have been recognized before the time given. It is difficult for anyone who has not been through it to understand what a herculean task it was to introduce even the simplest form of reports among these organizations. We asked the regimental officers to report to us every day the number of people excused from duty, and we insisted upon this report. After receiving it, I frequently sent an inspector around to find out how the consolidated report agreed with the regimental reports, and I would often find a difference of 50 or 60 between the reports. These inaccuracies were not confined to the medical department. It frequently happened that the consolidated monthly report showed a loss of more than 1,000 men. We kept no specific account of typhoid fever. We had a general record of the morbidity without reference to any one disease. There were many cases of measles and mumps, and a good many cases of fever diagnosticated as "malarial fever." A few of the cases were diagnosticated as "typhoid fever," but the latter were, in proportion to the whole, comparatively rare.

When asked if he could approximate the date on which he believed the general water supply became infected, Colonel Hoff stated:

I should say about July 20, judging from the rapid advance of the disease from that time. I do not mean to say that the number of cases began to increase immediately after July 20, but that the increase was more marked two or three weeks after this date, and this is the reason why I believe that there must have been some infection about that time from some source that was capable of producing a general infection. The water supply was the only thing the regiments were using in common. The advance of the disease so far as the First Division of the Third Army Corps is concerned was exceedingly slow. This division always had a lower curve than the Second Division, but the two curves went up simultaneously.

Colonel Hoff was of the opinion that the Second Division suffered more heavily than the First on account of the presence in the Second Division of the three highly infected regiments. He also believed that the infection spread from the Second Division through the First, notably through the Third Brigade of the First Division, which was encamped very near the Third Brigade of the Second Division.

The following figures show the relative prevalence of typhoid fever and the mortality from this disease in the two divisions of the Third Army Corps:

Total number of cases of probable typhoid fever in 8 regiments of the First Division (It will be seen that this includes the Second New York, which remained at Chickamauga only 12 days.)	1,853
Total number of cases of probable typhoid fever in the 9 regiments of the Second Division	2,565
Total number of deaths from typhoid fever in 8 regiments of the First Division	160
Total number of deaths from typhoid fever in the 9 regiments of the Second Division	257
Percentage of deaths among probable cases of typhoid fever in 8 regiments of the First Division	8.63
Percentage of deaths among probable cases of typhoid fever in the 9 regiments of the Second Division	10.01
Total number of cases of recognized typhoid fever in 8 regiments of the First Division	725
Total number of cases of recognized typhoid fever in the 9 regiments of the Second Division	1,016
Percentage of deaths among recognized cases of typhoid fever in 8 regiments of the First Division	22.06
Percentage of deaths among recognized cases of typhoid fever in the 9 regiments of the Second Division	25.29
Aggregate strength of the 8 regiments in the First Division	9,444
Aggregate strength of the 9 regiments in the Second Division	11,124
Percentage of cases of probable typhoid fever in 8 regiments of the First Division	19.62
Percentage of cases of probable typhoid fever in the 9 regiments of the Second Division	23.06

It will be seen from these figures that typhoid fever was both absolutely and relatively more prevalent in the Second Division than in the First Division of this corps.

Aggregate strength of the 17 regiments of this corps	20,568
Total number of cases of probable typhoid fever in the 17 regiments of this corps	4,418
Percentage of cases of probable typhoid fever in the 17 regiments of this corps	21.47
Total number of deaths from typhoid fever in the 17 regiments of this corps	417
Percentage of deaths among probable cases of typhoid fever in the 17 regiments of this corps	9.43

The following table will show the morbidity and mortality from typhoid fever in the Third Army Corps:

Commands.	Mean strength.	Cases of typhoid fever.		Deaths from typhoid fever.	Deaths from all diseases.
		Certain.	Certain and probable.		
FIRST DIVISION.					
14th New York	1,277	95	233	24	31
1st Missouri	1,275	46	216	11	14
5th Maryland	985	147	250	17	18
2d Nebraska	1,303	56	167	22	26
2d New York	1,014	46	161	30	31
3d Tennessee	1,293	61	123	12	19
1st Vermont	996	84	278	22	26
8th New York	1,301	190	425	22	23
Total	9,444	725	1,853	160	188
SECOND DIVISION.					
2d Kentucky	1,332	87	286	2[illegible]	30
9th New York	1,292	139	323	46	46
1st Arkansas	1,290	83	228	19	23
5th Missouri	1,274	51	212	14	16
2d Arkansas	1,291	95	287	17	26
69th New York	1,026	191	299	23	25
1st Maine	1,286	88	188	45	45
52d Iowa	1,304	184	345	36	37
1st Mississippi	1,029	98	397	29	33
Total	11,124	1,016	2,565	257	281
Total Third Army Corps	20,568	1,741	4,418	417	469

Commands.	Deaths from typhoid fever in 100 cases of—		Percentage of deaths from typhoid to deaths from all diseases.	Morbidity of typhoid fever in 1,000 mean strength—		Deaths from typhoid fever in 1,000 of mean strength.
	Certain typhoid.	Certain and probable.		For certain cases of typhoid.	For certain and probable cases of typhoid.	
FIRST DIVISION.						
14th New York	25.26	10.30	77.41	74.39	182.45	18.79
1st Missouri	23.91	5.09	78.57	36.07	169.41	8.62
5th Maryland	11.56	6.80	94.44	149.23	253.80	17.25
2d Nebraska	39.28	13.17	84.61	42.97	127.39	16.88
2d New York	65.21	18.63	96.77	45.36	158.77	29.58
3d Tennessee	19.65	9.75	63.15	47.17	95.12	9.28
1st Vermont	26.19	7.91	84.61	84.33	279 11	22.08
8th New York	11.57	5.17	95.65	146.04	318.98	16.91
Total	22.06	8.63	85.10	76.76	196.20	16.94
SECOND DIVISION.						
2d Kentucky	32.18	9.79	93.33	65.31	214.71	21.02
9th New York	33.09	14.24	100	107.58	250	35.60
1st Arkansas	22.89	8.33	82.60	64.34	176.74	14.72
5th Missouri	27.45	6.60	87.50	40.03	166.40	10.99
2d Arkansas	17.89	5.92	65.39	73.58	222.30	13.16
69th New York	12.04	7.69	92	186.15	291.42	22.41
1st Maine	51.13	23.93	100	68.42	146.19	34.99
52d Iowa	19.56	10.43	97.29	141.10	264.57	27.60
1st Mississippi	29.59	7.30	87.87	95.23	385.81	28.18
Total	25.29	10.01	91.45	91.33	230.58	23.10
Total Third Army Corps	23.95	9.43	88.91	84.64	214.79	20.27

CHAPTER VI.

GENERAL REMARKS CONCERNING TYPHOID FEVER IN THE FIRST AND THIRD ARMY CORPS.

Site.—The surface of Chickamauga Park is gently rolling, with sufficient grade to carry away the heaviest rainfalls. There are no morasses or swamps within the park. The surface is partly cleared and partly wooded, but everywhere the undergrowth has been cut out and there is nowhere dense forest. In some places local areas are somewhat flat and may be damp during a rainy season; especially is this true when the flat surface is covered with woods. With the exception of such localities as these there is no part of the park where an excellent site for a regimental camp might not be secured. Most of the little streams that drain the park are dry except after rains. However, some of them are fed by springs and flow continuously. Most of the drainage from the park passes ultimately into Chickamauga Creek, which flows along the southeastern border. A large part of the park is covered with magnesian limestone, upon which there has been deposited gravel, which varies in depth from a few inches to many feet. The strata of this limestone have been broken and thrown into ridges which dip at various angles. The outcropping rock is in many places broken and fissured in every direction, so that water easily percolates through the crevices and between the layers, frequently appearing on the surface and forming wet-weather springs. When the water penetrates greater masses of rock and passes for greater distances under the surface and accumulates in larger volume, permanent springs are formed. So far as the surface and soil are concerned there is only one objection to Chickamauga Park as an encampment for a large body of troops. This objection lies in the difficulty universally experienced in the summer of 1898 in digging sinks of sufficient size and depth and in having proper material with which the contents of these sinks could be covered. In many places the magnesian limestone lies directly on the surface. Pits could be made only by blasting, and when thus made were of insufficient size and could not be properly cared for.

It is a matter of some surprise that so many of the regiments located at Chickamauga should have encamped in the wooded portions. However, as has been stated, the woods were not dense anywhere, the undergrowth having been cut out so that it was easy to drive a team through any of the wooded portions of the park. There were some reasons for the regiments locating in the wooded rather than in the open spaces. In the first place many of the regular regiments were temporarily encamped in the park during April, 1898, before the arrival of the volunteer regiments. The regular troops left the park late in April or early in May, and most of these regiments went to Cuba. The volunteer regiments on arriving found that the

most desirable sites in the open portions of the park had already been occupied by the regular commands. Recognizing the fact that it was not safe to occupy sites so recently vacated by other regiments, the volunteers felt compelled in many instances to locate in the woods. In the second place, the open spaces were reserved in part for drill grounds. There were daily regimental and brigade drills and less frequently division and corps exercises. Thirdly, some of the open fields had been leased from the Government by individuals, who refused to allow the troops to occupy these lands. This necessitated negotiations, which took time, and in the meanwhile the regiments encamped in the woods. However, we do not think that a great deal of stress should be laid upon the fact that the regiments were encamped in the woods. As has been already stated, these woods were well lighted and penetrated by the rays of the sun in every part. It is possible that the site of the First Mississippi Volunteer Infantry was in a space too densely wooded.

So far as the locations of the camps are concerned, there is one criticism that must be made by anyone who knows anything of the sanitation of camps. There is no adequate reason why the regimental camp sites in Chickamauga Park should not have been changed every three weeks, and yet it is a fact that many a tent pitched there in May was not moved until the regiments dispersed late in August. The records show that regimental medical officers petitioned time and time again for a change in camp sites and that such petitions were in many instances wholly ignored. Everyone versed in camp sanitation knows that under the very best conditions any given site will become more or less contaminated when occupied for a few weeks, and it is strange that the desirability of frequent changes in camp sites in Chickamauga Park during the summer of 1898 was not recognized and acted upon by superior line officers.

On account of the rolling character of the surface and the geological formation already described, it sometimes happened that one regiment had its health endangered by drainage from other regiments. This was so plainly the case in the Second Division of the Third Army Corps that it is strange that it was not early recognized and that the camps of some of the regiments were not changed.

Drainage.—As has already been stated, nearly every acre in the park is provided with such excellent natural drainage that the excess of water falling upon it in the heaviest rain is soon removed. Numerous small streams wind among the slightly elevated knolls and act as natural sewers. One of the larger of these streams, known as Cave Spring Branch, through its tributaries receives the drainage of a large portion of the area covered by the encampments. This stream flows into Chickamauga Creek, and the relation of the junction of these two streams to the intake of the general water supply will be discussed later. On account of the variations in dip of the layers of limestone,

and also on account of the crevices in the layers of this stone, the drainage is not always on the surface. Water falling on an elevated area in the park in part passes down between the tilted and broken layers of limestone and reaches the surface at the foot of the hill. If the distance under ground traversed by the percolating water is short and the depth of penetration is not great, a wet-weather spring results; on the other hand, if a larger volume of water accumulates under the ground and percolates to a greater distance, a permanent spring results. The layers of limestone rock vary much in thickness. In many places they are superimposed one directly upon the other; in other localities the layers are separated by deposits of clay almost as hard as the rock itself, so that in drilling there is no noticeable difference between the rock and clay. For the reasons already given, the waters of many of the smaller springs, of some of the larger ones and of some of the wells, became more or less turbid after heavy rains. This can be accounted for only by contamination with surface drainage. It will be readily seen that with the conditions as here described a polluted surface necessarily led to polluted springs and wells.

Water supply.—Through and about the park are numerous large springs, supplying an almost unlimited quantity of water, which is apparently of the very best quality. Undoubtedly, when there is no unusual surface pollution about them, the water from any and all of these springs is quite safe. However, the largest of them may be contaminated to a greater or less extent by surface drainage. Crawfish Spring, the flow of which is estimated at 60,000,000 gallons per day, sometimes becomes muddy after heavy rains. In its normal state this is one of the most beautiful springs in the world. Numerous large springs, such as Sweet Spring, Blue Spring, Georgia Mineral Spring, Rossville Spring, etc., located outside of the park, furnished drinking water for the troops. From most of these springs water was dipped in pails, the man dipping the water standing upon the edge of the spring and with the water often undoubtedly falling over his boots and possibly contaminating the source of supply. The water was hauled to the camps from these springs in headless barrels. The barrels were deposited in the camp, and men dipped with clean and unclean cups, possibly with clean and unclean hands, water from these barrels and drank it. It must be admitted that the possibilities of occasional contamination of portions of the water obtained in this way were not insignificant.

We have already referred to the wet-weather springs. We are quite confident that these were a means of infection. Especially do we believe that this was true in the Second Division of the Third Army Corps. The location of some of the regiments of this corps was such that the contamination of wet-weather springs breaking out from the base of hills occupied by them was almost absolutely certain.

There are numerous wells throughout the park. These differ con-

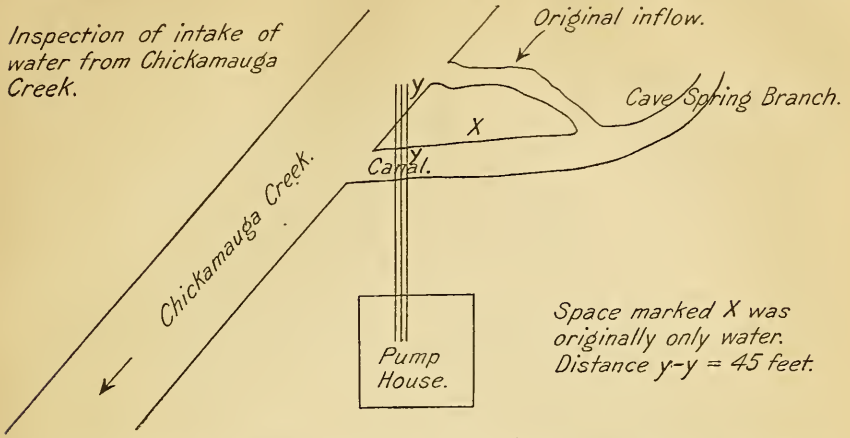
siderably in construction. It is generally believed that all of the wells in the park are driven ones. However, we have already seen from the testimony of Major Hysell that this is not true of Jay's Mill well. In regard to the wells General Boynton, chief commissioner of the park, made this statement to us:

> We had nine driven wells here when the troops began to arrive. These had been in use two or three years. Soon we saw that the supply from these would be insufficient. We obtained five drilling machines and began to put down wells as fast as we could wherever they were wanted. Most of this drilling was done before the rainy season set in. In boring for these wells we passed through gravel and loose rock near the surface, then we struck very solid rock, which ranged in thickness from 80 to 164 feet. A few of the wells are bored through less than 80 feet of rock, while others are carried through 164 feet of rock. In drilling there is no evidence of cavities. The water flows in when we get down to what we call the water-bearing stratum. Usually while boring it is found necessary to pour water into the hole to facilitate the action of the drill. After the water-bearing stratum has been reached, the water rises to within 10 feet of the surface, sometimes nearer. For instance, the well at the McDuffield place, which is 168 feet deep, was perfectly dry through 164 feet of rock, and immediately as soon as we got to the water-bearing stratum it came up to within 4 feet of the surface. At the Brotherton place the well is 125 feet deep, and most of it through solid rock, and the water goes to within 4 feet of the surface.

We found considerable diversity of statement concerning the inquiry as to whether or not the water from these driven wells became cloudy after heavy rains. General Boynton stated this occurred in only three wells within the park. He thought that in the case of these it could be explained only by contamination with surface drainage. Others stated that many of the wells in the park furnished turbid water after heavy rains. We think that there can be no doubt that there must have been surface contamination of at least some of these wells, and possibly the water from these may have served as a factor in the distribution of typhoid fever. The construction of these driven wells was apparently very good. The drill made an opening of a little more than 6 inches in diameter through the solid rock. Into this hole a wrought-iron casing was driven to a sufficient depth to make it water-tight. The casing above the rock was then set in hydraulic cement. Notwithstanding this care there can be no doubt, as above stated, that the water did occasionally become turbid, and when this happened the only explanation possible is that the turbidity was due to surface drainage.

In addition to the above-mentioned sources, water was pumped from Chickamauga Creek and distributed by means of pipes through the various organizations encamped in Chickamauga Park. The only troops that did not receive piped water from Chickamauga Creek was the Second Division of the First Army Corps. The regiments of this division were located quite distant from any of the pipes, and this water could have been used by men belonging to this division only

occasionally. The intake of the water supply from Chickamauga Creek was most unfortunate, as shown by the following illustration:



We have already mentioned the fact that a small stream, known as Cave Spring Branch, drained a large part of the territory covered by the encampments. This stream empties into Chickamauga Creek, and the intake of the general water supply was located dangerously near the junction of these streams. In fact, the intake of the water supply was immediately at the junction of the two streams. However, Cave Spring Branch was deflected from its course by a canal and dam, so that it emptied into Chickamauga Creek about 45 feet below the mouth of the intake pipes. The first attempt to deflect Cave Spring Branch consisted of a flimsy riprap wall, consisting of brush and broken stones. This poorly constructed dike was washed away by the first heavy rain, and Cave Spring Branch resumed its original course and flowed into Chickamauga Creek directly around the mouth of the three intake pipes. There certainly was no adequate excuse for taking the water from this point, and there can be but little doubt that the water supplied through the pipes did on more than one occasion become contaminated with the drainage from the camps flowing into Chickamauga Creek through Cave Spring Branch. With typhoid fever generally distributed through the regiments, the infection, as we have already seen, being brought to the park by most of the regiments, and with the drainage from all of these camps swept into this stream, it is impossible that the water of Cave Spring Branch should have escaped specific contamination with the typhoid bacillus, and it is well-nigh impossible that the water of Chickamauga Creek, pumped through the pipes and distributed through the camps, altogether escaped this contamination. In our opinion, there is but little doubt that the general water supply at Chickamauga became slightly contaminated. However, we are convinced from the distribution of the disease through the different organizations that contamination of the water supply was only one of

the means through which the disease was spread. Moreover, as we have already seen, the Second Division of the First Army Corps was quite removed in its location from the water mains and pipes, and the men of this division could only occasionally reach this water, and yet this division suffered like the others from typhoid fever. For these and other reasons that have already been given, we are inclined to think that infected water was not the chief source of the spread of typhoid fever among the troops encamped at Chickamauga.

Unfortunately no satisfactory bacteriological examination of any of the waters used by the troops at Chickamauga was made at the proper time. On August 5, 1898, Professor Slocum, of Knoxville, Tenn., made a chemical analysis of forty-three samples of water taken from various sources in the park. This analysis consisted of a determination of the amount of oxygen consumed. While we do not place any stress upon the value of these analyses, inasmuch as the evidence furnished is not convincing, we think ourselves justified in presenting in the following tabular form the results of Professor Slocum's work:

Results of analysis of water from various sources used by the troops in Camp George H. Thomas, Chickamauga Park, Georgia, August 5, 1898.

No.	Source.	Location.	Oxygen consumed in 100,000 parts.	Quality of water.	Remarks.
1	Well	Brotherton road at Howell's battery.	0.26	Impure	Cased well, not used.
2	Spring	Jay's mill	.09	Pure	
3	Well	Alexander road at Tom Little's, 12th Minnesota.	.06	do	Cased well.
4	do	Viniard-Alexander road, Walthall's shop.	.09	do	Do.
5	Spring	Mullis, north end of park	.10	do	
6	Well	Dyer House yard	.04	do	Do.
7	Spring	Blue, over Chickamauga Creek	.13	do	
8	do	Ellis, on Ringgold road	.04	do	
9	do	Cloud, on Lafayette road	.10	do	
10	Well	Reed's, Brotherton road, southwest of Brannan's, 160th Indiana.	.10	do	Do.
11	do	Dyer House, west of, near spring	.10	do	Do.
12	Spring	Dyer's, west of house	.21	Impure	Stock only.
13	Well	Wood's yard	.09	Pure	Cased well.
14	do	Brotherton road, at old county road.	.03	do	Do.
15	do	Brotherton road at Bragg's headquarters.	.17	Doubtful purity.	Cased well. Use stopped, but declared good after analysis by Philadelphia board of health or water board.
16	do	Lafayette road, south of Sawmill Fork.	.06	Pure	Cased well.
17	do	Brotherton road at Jay's Mill junction.	.07	do	Do.
18	do	Viniard House yard	.16	Medium purity	Open dug well.
19	do	Reed's, Brotherton road, west of 2d Minnesota monument.	.21	Impure	Cased well.
20	do	Brotherton House	.03	Pure	Do.
21	do	Lafayette road, 250 yards south of Brotherton's.	.09	do	Do.
22	do	Jay's mill road, north of Alexander road.	.04	do	Do.
23	do	Bagwell's store	.07	do	Open dug well.
24	Spring	White Smith's, near ravine	.15	Doubtful purity.	Shallow dug well. Use stopped early.
25	Well	Brannan's house yard (old well)	.26	do	Shallow dug well. Used by troops.
26	do	Brannan's front yard	.24	do	Cased well, finished among last.

Results of analysis of water from various sources, etc.—Continued.

No.	Source.	Location.	Oxygen consumed in 100,000 parts.	Quality of water.	Remarks.
27	Well	Benton's house yard	0.07	Pure	Shallow dug well.
28	do	Alexander Bridge road, between Wintrey's and Benton's.	.01	do	Cased well.
29	Spring	Brock field, west of	.20	Doubtful purity.	Deep spring. Use stopped early.
30	Well	Poe field, northeast of Georgia monument.	.06	Pure	Cased well.
31	do	Poe field, east of Georgia monument.		Sample broken.	Do.
32	do	Lafayette road, Kelly house	.06	Pure	Do.
33	do	Glenn-Kelly and Baird road, Dyer field	.03	do	Do.
34	Spring	Dyer field, at water oak	.09	do	Bold, shallow spring.
35	Well	Lafayette road, north of Kelly house.	.03	do	Cased well.
36	do	Lafayette and Alexander roads	.10	do	Do.
37	do	Lafayette and Reeds Bridge roads.	.10	do	Do.
38	do	Glenn-Kelly and Snodgrass roads.	.10	do	Do.
39	Pipe line.		.03	Medium purity.	Pipe line, Chickamauga Creek.
40	Well	Rostrum, foot of Snodgrass Hill	.15	Doubtful purity.	Cased well, not used.
41	do	Vittetoe roads, near Vittetoes	.03	Pure	Cased well.
42	do	Lytle Hill, on Glenn-Kelly road	.42	do	Do.
43	Spring	Scott's, south of Viniard's	.10	do	Large, shallow, open spring.

Classification of Frankland and Tidy.

Oxygen consumed in 100,000 parts of water.

Section 1.—Upland surface water—

Class 1.—Water, great organic purity not more than 0.1

2.—Water, medium purity not more than ..... .21

3.—Water, doubtful purity not more than 4

4.—Water, impure more than 4

Section 2.—Deep wells and springs—

Class 1.—Water, great organic purity not more than ..... .055

2.—Water, medium purity not more than ..... .15

3.—Water, doubtful purity not more than 2

4.—Water, impure more than 2

In September, 1898, Acting Assistant Surgeon Carroll, under the direction of our board, collected samples of water from various sources in Chickamauga Park and submitted the same to bacteriological examination. Of course we understand that the bacterial flora of these waters in September does not represent the condition of the same waters in August. However, we had the waters examined as soon as we were able to do so. We publish in the attached tables the results of Dr. Carroll's work. It will be seen that he found the bacillus pyocyaneus in many of these waters. We do not know that any importance whatever is to be attached to the wide distribution of this bacillus in the waters of Chickamauga Park, nor shall we attempt to draw any conclusions therefrom. This organism has been found occasionally in the drinking water supplied to various cities. We give the results of Dr. Carroll's work without further comment.

Results obtained with water from Camp George H. Thomas, Chickamauga Park, Georgia, collected September 27, 1898.

No.	Location of well or spring.	4-day culture at 39° to 41° C.	Guinea pig, weight.	Died.
			Grams.	
1	At foot of Lytle Hill headquarters	Plain bouillon ,1 c. c	350	17 hours.
2	Headquarters well, outside	do	460	18 hours.
3	Dyer House spring, open for stock	do	425	17 hours.
4	Well yard at park headquarters	do	365	Do.
5	Wood's well at park headquarters	do	470	Do.
6	Dyer field spring	do	415	25 hours.
7	Well at junction of Bayard and Kelly roads.	do	450	17 hours.
8	At Snodgrass crossroads	do	420	Do.
9	Well at west fork of Glenn-Kelly road, north of Snodgrass crossroads.	do	585	Do.
10	First well south of stone crusher, Glenn-Kelly road, west fork.	do	430	Do.
11	Mullis spring	do	725	Do.
12	McDonald well	do	340	
13	Cloud spring, said to be responsible for a number of cases, open, water dipped.	do	305	Do.
14	Alexander well, Alexander and Lafayette roads.	do	345	Do.
15	Glenn-Kelly road, west of Kelly field	do	320	Do.
16	Kelly field well, Lafayette road	do	520	Do.
17	Kelly House well	do	570	24 hours.
18	Well east of north end of Poe field	do	415	17 hours.
19	Shallow well in hard rock, east of Poe field, opposite Georgia State monument.	do	360	Do.
20	Brotherton well, on Lafayette road	do	345	Do.
21	On Lafayette road, south of Brotherton's, near Humphries' Arkansas Battery.	do	495	Do
22	Means spring, open, water dipped	do	660	25 hours.
23	Well on Lafayette road, south of sawmill fork of Glenn-Kelly road.	do	320	17 hours.
24	Viniard-Alexander road at Blacker's house.	do	355	Do.
25	Scott spring, open, dipped	do	325	Do.
26	Chickamauga Creek, one-fourth mile above intake.	do	575	11 days.
27	Chickamauga Creek at intake	do	615	17 hours.
28	Cave Spring Branch	do	615	11 days.
29	Well on Viniard-Alexander road, 300 yards east of road to Hall's tower.	do	335	34 hours.
30	Well on Alexander road, north of Alexander house 250 yards.	do	625	Do.
31	Well on Viniard-Alexander road, at old blacksmith shop of Walthall.	do	355	17 hours.
32	Well on Jay's Mill road, 100 yards north of Alexander junction.	do	370	41 hours.
33	Well on Alexander Bridge road, at Osborne's house.	do	390	11 days.
34	Well on the old Alexander (county) road, halfway between Brotherton and Jay's Mill roads.	do	395	21 days.
35	Well on Alexander road, between the Winfrey and Osborne houses.	do	350	34 hours.
36	Well on Brotherton road, at junction of old Alexander (county) road.	do	755	17 hours.
37	Well on Brotherton road, at Howell's battery; bottle lowered with string.	do	420	23 hours.
38	Well on Brotherton road, at Bragg's headquarters monument.	do	495	30 hours.
39	Well on Jay's Mill road, 200 feet south of Brotherton road.	do	435	17 hours.
40	Jay's Mill spring	do	345	Do.
41	Well on Reed's Bridge road, at Brannan's (Peter's) house.	do	545	Do.
42	Well on the Jay's Mill branch, 400 yards west of Brannan's house.	do	415	Do.
43	Well on Reed's Bridge road, halfway between Second Minnesota monument and the road from the tower.	do	340	Do.
44	Crawfish Spring, at Leiter Hospital, outside.	do	370	Do.
45	Crawfish Spring water, from Leiter Hospital faucet.	do	Not noted.	23 hours.

Results obtained with water from Camp George H. Thomas, etc.—Continued.

No.	Location of well or spring.	5-day culture at 39° to 41° C.	Guinea pig, weight.	Died.	Organism obtained.
			Grams.		
1	At foot of Lytle Hill headquarters	Gas tube, 0.3 c. c.	227		Pyocyaneus, first pig.
2	Headquarters well, outside	do	240	10 days	
3	Dyer House spring, open for stock	do	240		Do.
4	Well yard at park headquarters	do	227	17 hours	Pyocyaneus, first and second pigs.
5	Wood's well at park headquarters	do	232		Pyocyaneus, first pig.
6	Dyer field spring	do	240	11 days	
7	Well at junction of Bayard and Kelly roads.	do	256	do	Do.
8	At Snodgrass crossroads	do	250		Do.
9	Well at west fork of Glenn-Kelly road, north of Snodgrass cross roads	do	250		Do.
10	First well south of stone crusher, Glenn-Kelly road, west fork.	do	275	14 hours	Pyocyaneus, second pig.
11	Mullis spring	do	245		Pyocyaneus, first pig.
12	McDonald well	do	355	10 days	
13	Cloud spring, said to be responsible for a number of cases, open, water dipped.	do	270	22 hours	Pyocyaneus, both pigs.
14	Alexander well, Alexander and Lafayette roads.	do	300	14 hours	Pyocyaneus, second pig.
15	Glenn-Kelly road, west of Kelly field	do	320	do	Do.
16	Kelly field well, Lafayette road	do	275	12 hours	Pyocyaneus, first pig.
17	Kelly house well	do	270	15 hours	
18	Well east of north end of Poe field	do	310	24 hours	Pyocyaneus, both pigs.
19	Shallow well in hard rock, east of Poe field, opposite Georgia State monument.	do	210	10 days	Pyocyaneus, first pig.
20	Brotherton well, on Lafayette road	do	645	32 hours	Pyocyaneus, both pigs.
21	On Lafayette road, south of Brotherton's, near Humphries' Arkansas Battery.	do	535	17 hours	Pyocyaneus, first pig.
22	Means spring, open, water dipped	do	310		
23	Well on Layfayette road, south of sawmill, fork of Glenn-Kelly road.	do	415		Do.
24	Viniard-Alexander road at Blacke's house.	do	360	23 hours	Pyocyaneus, both pigs.
25	Scott spring, open, dipped	do	250	6 hours	Do.
26	Chickamauga Creek, one-fourth mile above intake.	do	275		
27	Chickamauga Creek at intake	do	395	19 days	Pyocyaneus, first pig.
28	Cave Spring Branch	do	245	10 days	
29	Well on Viniard-Alexander road, 300 yards east of road to Hall's tower.	do	235	20 days	
30	Well on Alexander road, north of Alexander house 250 yards.	do	740		
31	Well on Viniard-Alexander road, at old blacksmith shop of Walthall.	do	313	9 days	Do.
32	Well on Jay's Mill road, 100 yards north of Alexander Junction.	do	550		Do.
33	Well on Alexander Bridge road, at Osborne's house.	do	565		
34	Well on the old Alexander (county) road, halfway between Brotherton and Jay's Mill roads.	do	610		
35	Well on Alexander road, between the Winfrey and Osborne houses.	do	485		Do.
36	Well on Brotherton road, at junction of old Alexander (county) road.	do	515	5 days	Do.
37	Well on Brotherton road, at Howell's battery; bottle lowered with string.	do	545	34 hours	
38	Well on Brotherton road, at Bragg's headquarters monument.	do	300	22 hours	Pyocyaneus, second pig.
39	Well on Jay's Mill road, 200 feet south of Brotherton road.	do	345	20 days	
40	Jay's Mill spring	do	355		
41	Well on Reed's Bridge road, at Brannan's (Peter's) house.	do	305		Pyocyaneus, first pig.
42	Well on the Jay's Mill branch, 400 yards west of Brannan's house.	do	265		Do.
43	Well on Reed's Bridge road, halfway between Second Minnesota monument and the road from the tower.	do[1]			Do.
44	Crawfish Spring, at Leiter Hospital, outside.	do[1]			Do.
45	Crawfish Spring water, from Leiter Hospital faucet.	do[1]			Do.

[1] Tubes exhausted.

Results obtained with water from Camp George H. Thomas, etc.—Continued.

No.	Location of well or spring.	Fermentation test.					Condition of water.
		Sugar.	First day.	Second day.	Fourth day.	Fifth day.	
			Cm.	*Cm.*	*Cm.*	*Cm.*	
1	At foot of Lytle Hill headquarters	Lactose	6.0	6.8	Max.	.....	Clouded.
2	Headquarters well, outside	Saccharose	6.2	12.0	12.4	.....	Clear.
3	Dyer house spring, open for stock	Glucose	5.5	7.6	Max.	.....	Do.
4	Well yard at park headquarters	Lactose	.6	2.0	2.2	Max.	Do.
5	Wood's well at park headquarters.	Glucose	4.2	5.3	Max.	.....	Do.
6	Dyer field spring	Saccharose	4.6	7.5	8.0	Max.	Quite cloudy.
7	Well at junction of Bayard and Kelly roads.	Glucose	2.5	6.1	6.6	Max.	Do.
8	At Snodgrass crossroads	Lactose	3.0	4.8	Max.	.....	Clear.
9	Well at west fork of Glenn-Kelly road, north of Snodgrass crossroads.	Glucose	0	0	0	0	Do.
10	First well south of stone crusher, Glenn-Kelly road, west fork.	Lactose	.6	9.0	Max.	.....	Do.
11	Mullis spring	do	4.8	5.5	Max.	.....	Slightly opalescent
12	McDonald well	Saccharose	1.2	2.0	3.2	3.5	Clear.
13	Cloud spring, said to be responsible for a number of cases, open, water dipped.	Lactose	6.5	8.5	Max.	.....	Do.
14	Alexander well, Alexander and Lafayette roads.	Glucose	5.0	11.5	11.6	Max.	Very cloudy.
15	Glenn-Kelly road, west of Kelly field.	do	1.2	4.5	Max.	.....	Clouded.
16	Kelly field well, Lafayette road	Saccharose	0	1.5	Max.	.....	Very cloudy.
17	Kelly house well	do	0	0	0	0	Opaque yellowish.
18	Well east of north end of Poe field	Lactose	1.3	5.0	6.1	Max.	Quite clouded.
19	Shallow well in hard rock, east of Poe field, opposite Georgia State monument.	do	1.5	4.8	6.4	Max.	Pale brownish yellow in color.
20	Brotherton well, on Lafayette road.	Saccharose	0	0	0	0	Clear.
21	On Lafayette road, south of Brotherton's, near Humphries' Arkansas Battery.	Glucose	2.7	8.5	9.5	Max.	Opaque dirty brownish yellow in color.
22	Means spring, open, water dipped	Saccharose	5.0	10.6	.....	.....	Clear.
23	Well on Lafayette road, south of sawmill, fork of Glenn-Kelly road.	Glucose	4.3	Max.	.....	.....	Clouded, dirty looking.
24	Viniard-Alexander road at Blacker's house.	do	4.2	9.0	10.1	Max.	Clear.
25	Scott spring, open, dipped	Lactose	5.0	5.6	Max.	.....	Slightly opalescent.
26	Chickamauga Creek, one-fourth mile above intake.	do	6.0	6.6	Max.	.....	Clouded.
27	Chickamauga Creek at intake	Saccharose	6.0	9.6	Max.	.....	Do.
28	Cave Spring Branch	do	3.6	7.8	Max.	.....	Slightly cloudy.
29	Well on Viniard-Alexander road, 300 yards east of road to Hall's tower.	do	0	2.0	2.3	2.5	Clear.
30	Well on Alexander road, north of Alexander house 250 yards.	do	2.1	6.0	Max.	.....	Quite cloudy.
31	Well on Viniard-Alexander road, at old blacksmith shop of Walthall.	Lactose	0	0	0	0	Clouded.
32	Well on Jay's Mill road, 100 yards north of Alexander Junction.	Glucose	3.3	4.0	Max.	.....	Clear.
33	Well on Alexander Bridge road, at Osborne's house.	do	0	0	0	0	Do.
34	Well on the old Alexander (county) road, halfway between Brotherton and Jay's Mill roads.	do	.6	3.0	3.4	Max.	Slightly clouded.
35	Well on Alexander road, between the Winfrey and Osborne houses.	do	0	0	0	0	Do.
36	Well on Brotherton road, at junction of old Alexander (county) road.	Saccharose	0	0	0	0	Clear.
37	Well on Brotherton road, at Howell's battery; bottle lowered with string.	Lactose	2.0	6.6	10.3	Max.	Quite clouded; murky.
38	Well on Brotherton road, at Bragg's headquarters monument.	Saccharose	0	0	0	0	Clear.

Results obtained with water from Camp George H. Thomas, etc.—Continued.

No.	Location of well or spring.	Fermentation test.					Condition of water.
		Sugar.	First day.	Second day.	Fourth day.	Fifth day.	
			Cm.	*Cm.*	*Cm.*	*Cm.*	
39	Well on Jay's Mill road, 200 feet south of Brotherton road.	Glucose	2.4	4.6	9.0	Max.	Opaque; very cloudy.
40	Jay's Mill spring	Lactose	3.5	10.0	11.0	Max.	Clouded; rust colored.
41	Well on Reed's Bridge road, at Brannan's (Peter's) house.	Glucose	3.8	6.5	Max.	------	Clear.
42	Well on the Jay's Mill branch, 400 yards west of Brannan's house.	do	3.0	7.5	8.3	Max.	Clouded.
43	Well on Reed's Bridge road, halfway between Second Minnesota monument and the road from the tower.	------	------	------	------	------	Opaque; dirty looking.
44	Crawfish Spring, at Leiter Hospital, outside.	------	------	------	------	------	Clear.
45	Crawfish Spring water, from Leiter Hospital faucet.	------	------	------	------	------	Do.

Acting Asst. Surg. Charles F. Craig in his report from the bacteriological laboratory of Sternberg Hospital, to be appended later, gives some information concerning the bacteriology of some of the waters in the park. However, as his report refers chiefly to the existence of malaria, we will give the results of his work under that head.

In order to show that many of the medical officers at Chickamauga Park realized the gravity of the situation early in the season, we give from the large list of papers in our possession the following:

HEADQUARTERS FIRST BRIGADE,
THIRD DIVISION, FIRST ARMY CORPS,
Camp George H. Thomas, Chickamauga, Ga., June 27, 1898.

SIR: Owing to the amount of diarrheal trouble and the increase of typhoid and other fevers in this brigade, I have the honor to recommend that the command be required to use only boiled water for drinking purposes. The present directions for boiling water are not carried out. This is partly due to the want of proper utensils and facilities for storing water. I would recommend that ordinary wash boilers be obtained for boiling the water, and the proper number of barrels for storing and cooling it be procured, but that the command be required to utilize such things as they may have until the desired equipment has been obtained.

As the rear sinks are infected by the excreta of patients with typhoid fever, I would recommend that chloride of lime be obtained in large quantities for their disinfection, and that every man using the sinks be required to use earth, or a mixture of earth and lime, at once, so that at no time will excreta be exposed to the air and flies.

As this is a very important matter, I would recommend that urgent measures be taken to procure the boilers, barrels, and lime at once, without regard to the ordinary methods of business.

I remain, very respectfully,

J. D. GLENNAN,
Major and Surgeon, U. S. V., Brigade Surgeon.

THE ASSISTANT ADJUTANT-GENERAL,
First Brigade, Third Division, First Army Corps.

Sinks.—The difficulty that was experienced in digging sinks of proper depth has already been frequently referred to. The rocky nature of the soil in many places made it well nigh impossible to provide sinks of proper dimensions. When rock has to be blasted in order to prepare a sink, the result must always be more or less unsatisfactory. However, the difficulty in providing and caring for the sinks was not confined to their construction. The amount of dirt thrown out in the digging of these sinks was inconsiderable, and after it had been on the surface in the sun it became almost as hard and nonporous as rock. When this dirt was thrown back into the sink, it did not absorb the liquid contents, but simply displaced the watery material, and when thrown in in considerable quantities caused the sinks to overflow. There was an almost universal complaint from regimental medical officers that lime could not be obtained early in the season for the disinfection of sinks. It seems strange that no one apparently ever thought of the possibility of manufacturing enough lime to supply the entire encampment. There is in the park practically an unlimited supply of wood, and certainly an unlimited supply of limestone rock. The construction of a few limekilns would not have been a herculean task with the large number of men on hand, and this might have supplied an abundance of lime. However, we are satisfied that if there had been no shortage in lime the condition of affairs would not have been greatly improved. The thorough disinfection of the excretions of 60,000 men, when deposited in pits in the earth, and especially when scattered on the surface of the earth, is not an easy task. We may regard it as an axiom that wherever and whenever a large number of men assemble and allow their own excretions to accumulate about them, there and then typhoid fever will appear and will spread.

We do not mean to imply by this that typhoid fever ever originates de novo, nor do we mean to have anyone understand that we believe that the colon bacillus, or any other germ present in the normal excretions of men, can develop into the typhoid bacillus. We do mean that typhoid fever is so widely distributed that in any large assembly of men collected from different parts of the country there will be some already infected with typhoid fever. From the dejections of these the typhoid bacillus will grow and flourish in polluted places, and the disease will develop and spread. If the troops at Chickamauga had been provided with ample means for disinfecting all excretions, we do not suppose that even under these conditions typhoid fever would have been altogether unknown, but the disease might have been limited to the men who reached the camp infected and there could have been no widespread epidemic. We are quite thoroughly convinced that some substitute must be provided for the pit system in permanent camps. While troops are on the march, stopping here and there for a day or two at most, pits for the disposition of fecal matter are sufficient, but in permanent camps

they always have been, are, and probably always will be, a menace to the health of any command. While it is true that it was well nigh impossible to properly construct sinks at Chickamauga, it must not be forgotten that in other encampments where there was no difficulty in digging sinks and where there was no scarcity of earth suitable for covering their contents typoid fever prevailed extensively. It has been urged by some that the great prevalence of typhoid fever at Chickamauga was due to the fact that such large numbers of troops were massed at one place. Relatively there is some truth in this, but at no time was the density of the soldier population of Chickamauga Park as great as that of many of our cities in which typhoid is a rare disease. It can not, therefore, be truly said that typhoid fever at Chickamauga was the result of the massing of a large number of men. At least the spread of the disease was only incidental to this. If the excretions of these men could have been carried away by means of properly constructed sewers, or if they could have been disinfected, and if camp pollution had not been permitted, and if a pure water supply had been obtained, there is no reason why typhoid fever should have been more prevalent among the troops at Chickamauga in the summer of 1898 than it was in New York City.

We repeat that, in our opinion, the sink must no longer be permitted in permanent encampments. When possible, water carriage for fecal matter may be adopted, and when this is impracticable the thorough disinfection of all fecal matter in tubs as recommended by this board will, we believe, reduce typhoid fever in permanent encampments to a few sporadic cases.

Camp pollution.—The greatest sanitary sin committed among the troops at Chickamauga in 1898, as well as in most other national encampments, was that of camp pollution. Some of the regimental camp sites became most disgustingly filthy. It is unnecessary to repeat our evidence on this point. Reference to the regimental histories already recorded will give one some idea of the condition of some of these camps. A few extracts from our stenographic notes, taken at the time of our inspection, further illustrate this point:

In the camp of the Third U. S. Volunteer Cavalry we found the sinks full to the top with fecal matter; soiled paper was scattered about the sinks, and the woods behind the regimental camp was strewn with fecal matter. The Second Kentucky Volunteer Infantry was located in the woods; fecal matter was deposited around trees, and flies swarmed over these deposits not more than 150 feet from the company mess tents; the odor in the woods just outside of the regimental lines was vile. In the Ninth New York we found three battalion sinks supposed to have been filled with straw and burned out that morning. Fecal matter was found deposited on the ground around trees, and a vile odor permeated the air about the sinks.

We found in the hospital of the Third Division of the First Army Corps that the stools were not disinfected at all. The bedpans were washed in water and were not disinfected. The fecal matter of attendants was received in galvanized-iron boxes of very imperfect pattern.

There was abundant opportunity for the outside of the boxes to become foul, and there was no means provided for properly handling these boxes. These are illustrations of the condition that we found at Chickamauga. When our board visited Chickamauga most of the regiments had already departed, and it was expected that only the Sixth U. S. Volunteer Infantry would remain. The following is a copy of our recommendations to General Boynton concerning the care that should be practiced by this regiment:

KNOXVILLE, TENN., *September 14, 1898.*

GENERAL: The board of medical officers convened by Special Orders, No. 194, paragraph 40, Adjutant-General's Office, Washington, D. C., August 18, 1898, for the special investigation of the origin and spread of typhoid fever in the army camps, begs to submit the following recommendations concerning the Sixth U. S. Volunteer Infantry, the only regiment now encamped at Chickamauga Park:

1. Water supply.—The men of this regiment, being supplied with a presumably pure water from Mullis Spring, should be compelled to use this water only and no other for any purpose whatever. Every precaution should be taken to see that patrol parties should be supplied with drinking water from this source whenever absent from camp on such duty. Suitable bath houses should be erected for the use of the men and they should be compelled to use this water for bathing purposes. Under no circumstances should Chickamauga Creek water or water from any other source than this spring be used. If the regiment should be ordered out for a march, water from Mullis Spring in abundant quantity should be carried along for drinking purposes. From an inspection of this spring and its immediate surroundings made by the board, we recommend that immediate measures be taken to protect the spring against surface drainage. The barrels used for the purpose of storing drinking water should be elevated on supports, furnished with stopcocks for withdrawing the water, supplied with tight covers, and protected from the sun by a proper shelter; they should be frequently inspected and from time to time cleansed and their interiors exposed to the direct sunlight for some hours.

2. Mess tents and kitchens.—No measures should be omitted to prevent the access of flies to the food. The board therefore urgently recommends that both kitchens and mess tents should be promptly and thoroughly screened. All milk consumed should be boiled and thereafter protected from the flies by proper screens. As an additional precaution the cooks and attendants about the kitchens and mess tents should be compelled to thoroughly and frequently wash their hands with soap and water every time they go to the kitchen and mess tents for the performance of their duty. None but authorized persons should be permitted to handle the food supplies. Soldiers should be forbidden eating any fruit or drinking any liquid except that furnished by the regiment. Men should be compelled to thoroughly wash their hands before going to meals.

3. Kitchen garbage.—Suitable vessels should be provided for the reception of kitchen garbage. These should be daily removed and their contents buried or burned at some point distant from the camp; for the garbage, zinc barrels with proper covers are recommended.

4. Company sinks.—At the time of the inspection by the board the sinks were in foul condition; exposed fecal matter was found in every sink. The board can not too strongly emphasize the necessity of each individual being absolutely required to cover his own excrement with dry earth before leaving the sink, and this should not be left to men detailed for the purpose, as with details fecal matter is left exposed for hours to the access of flies. The sinks should be sheltered, and ditched so as to prevent the access of surface water to them. If the dry earth closets should be adopted a box should be provided separately for each hole, and should be wide enough to receive the urine and fecal matter without danger of

these being deposited outside of or on the exterior surfaces of boxes, as will happen with the boxes now in use at Sternberg Hospital, for instance. An abundance of well-dried and pulverized earth should be provided in storage, completely sheltered from the rain. This should be freely used in the boxes, each man being compelled to cover his excrement as in case of the sink. In addition to the dry earth, lime should be used at least once a day, besides always being freely placed in the boxes after emptying them. In order to insure the execution of this measure, if necessary a sentinel should be placed at each sink or closet with positive instructions for its enforcement.

5. Tents.—All tents should have a flooring raised at least 6 inches above the ground, and if practicable the soldiers should be provided with cots. All bedding and blankets should be daily exposed to the direct sunlight. Men should be compelled to remove their outer clothing at night. The floors of all the tents should be kept clean.

6. Regimental hospital.—All men with fever should be immediately removed to the hospital. The most thorough disinfection of the stools and urine of all patients under treatment in the hospital, and of all bed clothing and personal linen should be required as a matter of routine. This recommendation should apply not only to all fever patients but also to all others. For the purposes of disinfection a solution consisting of 1 part of carbolic acid to 30 parts of water should be prepared in large quantities and stored in barrels readily accessible as the sole disinfectant. A pint of this should be placed in each bedpan before it receives the discharge from the patient; when the bedpan is removed an additional pint of the solution should be added and the vessel carried to the sink, emptied, and afterwards thoroughly washed with the same disinfecting solution. After each stool the patient's buttocks should be carefully cleansed with this solution. Whenever any fecal matter is spilled upon the floors or ground the spot should be immediately cleaned and disinfected with this solution. All soiled personal and bed linen should be immediately removed and at once immersed in the same carbolic solution for at least two hours. Mattresses, bed linen, and blankets should be daily exposed to the direct sunlight when not in use. All hospital-tent floors should be scrubbed daily with this solution. The greatest attention should be paid to the disinfection and condition of the hospital sink, in addition to the thorough disinfection of all stools; lime and dry earth should be thrown into the sinks. The possibility of flies gaining access to any fecal matter in the sinks should be absolutely prevented by this means. Attendants should be required to disinfect their hands after attending each patient in each instance. The recommendations made with reference to the company mess tents and kitchens apply with special force to the hospital mess tents and kitchens.

The foregoing apparently minute details concerning water supply, mess tents and kitchens, garbage, company sinks, tentage, and hospital must be carried out in every particular if typhoid fever, already present in this command, is to be stamped out. We therefore recommend that each one of these sanitary regulations be placed upon the status of military discipline, and that an infraction of any of them be as severely punished as any other breach of discipline. In no other way can immunity be secured to this regiment of "immunes."

Very respectfully,

WALTER REED,
Major and Surgeon, U. S. V.
VICTOR C. VAUGHAN,
Major and Division Surgeon, U. S. V.
E. O. SHAKESPEARE,
Major and Brigade Surgeon, U. S. V.

Brig. Gen. H. V. BOYNTON,
Camp George H. Thomas, Chickamauga Park, Georgia.

Subsequently we recommended that the galvanized-iron boxes prepared by our board and adopted by the Surgeon-General should be used in place of sinks.

After inspecting the Second Division of the First Army Corps at Knoxville, the board made the following report:

KNOXVILLE, TENN., *September 16, 1898.*

SIR: The board of medical officers convened per Special Orders, No. 194, paragraph 40, Adjutant-General's Office, Washington, D. C., August 18, 1898, respectfully submit the following recommendation in compliance with the provisions of said orders:

1. Water supply.—As far as the board has been able to judge the water supply appears to be of good quality. The supply of the city of Knoxville proper has been used by the Fourth Tennessee Volunteer Infantry for more than two months, and although there are a few cases of typhoid fever in this regiment, these are plainly not due to water contamination. The supply of West Knoxville is presumably of good quality.

2. (*a*) *Kitchen sinks.*—All garbage should be received into water-tight barrels and carried away from the camps daily; wash water should be thrown into pits to which dry earth and ashes are daily used for covering. As a rule, kitchen sinks have been found in good sanitary condition. The best cared-for kitchen sinks are those of the First West Virginia and Sixth Ohio; the worst those of the Thirty-first Michigan, Second Ohio, First Pennsylvania, and Fourteenth Minnesota. Earth should be placed in the sinks whenever fluid garbage is emptied into them. There is needed frequent inspection of these sinks by company and medical officers to insure a good sanitary condition.

(*b*) *Company sinks.*—With the presence of typhoid fever among the men of every regiment constituting this division, except the Sixth Virginia Infantry (a recently recruited regiment), the board must express considerable surprise that so little attention is given to the condition of these sinks; not one was found to be properly cared for; exposed fecal matter, with attendant flies, was found in every sink. The sinks of the Sixth Ohio were in the best condition; the remainder were foul and offensive. This condition, a constant menace to health, should not be tolerated any longer. Every soldier in this command should be compelled to cover with dry earth his excrement as soon as deposited. In no other way can sinks be kept in a safe and sanitary condition. If necessary to enforce this order sentinels should be placed near each sink to see that men cover at once their excrement. The proposal to keep sinks dark is not considered advisable. Light should be admitted so that the sink can be inspected at all times. Once each day lime should be freely used to cover the margins, sides, and bottoms of all sinks. In the opinion of the board no sanitary measure is so important for the health of this command as such care of sinks as has been recommended above. At the inspection made this day of the camp site of the Sixth Virginia and Third North Carolina Infantry, it was found that the men of both of these regiments were using the abandoned sinks of the First Pennsylvania Regiment. These sinks were found to be in an indescribably filthy condition, disgraceful to any command; not even a shovelful of earth had been placed in any sink. If such condition of the sinks of this command is to be permitted, then all efforts to stamp out typhoid fever will be of no avail. Already typhoid fever has appeared among the men of one of these regiments (Third North Carolina).

We visited the camp of the Fourth Tennessee with considerable interest, as we had understood that this regiment had so far escaped typhoid fever. However, we found they had already had 1 death from this disease, and there are now 2 cases of typhoid fever in their regimental hospital. This command has a regi-

mental sink to which no attention is given, and its condition is such as to practically guarantee the distribution of typhoid fever throughout the regiment. We learn that this regiment intends to adopt the "tub" system of disposing of fecal matter. If there be any form of disposition of fecal matter more dangerous to the soldier than the unkept sink it is the tub. We have seen abundant evidence of this in the Seventh Army Corps. The tub is a portable privy, often laden with typhoid infection, which is scattered from the privy to the place where the matter is deposited. We beg to protest most earnestly against the tub system. We suggest that battalion sinks be properly constructed and properly cared for in this regiment. If this be done there is the possibility of stamping out the disease. We feel quite certain that the medical officer of this regiment will fail to recognize typhoid fever in its early stage. We therefore recommend that the sanitary inspector visit this regiment at least twice each week, and that he not only inspect the sinks, but also examine the patients in the regimental hospital and in quarters, and, should new cases appear, this regiment should be immediately moved to another site. This suggestion, that the sanitary inspector look after regimental hospitals, should apply to all regiments having such hospitals. He should see that the stools of all patients in these hospitals are properly disinfected. Unless constant attention be given to the care of sinks and the disinfection of stools, the experience at Chickamauga will be repeated at Knoxville.

3. The division hospital.—The board made an inspection of this hospital on the 14th instant. The number of patients on this date was about 235. The wards were found to be overcrowded, as many as 7 or 8 patients being in each tent. The floors of the general pavilion, as well as of the tents, were in a filthy condition. As far as the board was able to judge by inspection and by questioning the nurses, no attention was paid to the disinfection of either stools or personal or bed linen. Patients with garments soiled with typhoid discharges were found in one of the wards. Bedpans used for the patients were soiled with discharges not disinfected. Open vessels containing the nondisinfected discharges of typhoid patients were being carried from the wards to the sink, there emptied without disinfection, and the contents allowed to drop upon the surrounding ground. The sink intended for the reception of typhoid discharges was very offensive. The margins and sides of the sink were in like condition. It was evident upon inspection that the surgeon in charge had no appreciation of the need of disinfection of stools or linen or of the need of cleanliness in the hospital. The board found the number of nurses to be insufficient. In the opinion of the board no time should be lost in securing the services of trained female nurses for this hospital, in order to enable proper care and attention to be given to the sick.

The most thorough disinfection of all stools and urine of all patients under treatment in the hospital, and of all bed clothing and personal linen, should be required as a matter of routine. This recommendation should apply not only to all fever patients, but also to all others. For the purposes of disinfection, a solution consisting of one part of carbolic acid to thirty parts of water should be prepared in large quantities and stored in barrels readily accessible as the sole disinfectant. A pint of this should be placed in each bedpan before it receives the discharge from the patient. When the bedpan is removed an additional pint of the solution should be added and the vessel carried to the sink, emptied, and afterwards thoroughly washed with the same disinfectant solution. After each stool the patient's buttocks should be carefully cleansed with the same disinfectant solution. Whenever any fecal matter is spilled upon the floors or ground, the spot should be immediately cleaned and disinfected with this solution. All soiled personal and bed linen should be immediately removed and at once immersed in the same carbolic solution for at least two hours. Mattresses, bed linen, and blankets should be daily exposed to the direct sunlight when not in use. All hos-

pital tent floors should be scrubbed daily with this solution. The greatest attention should be paid to the disinfection and condition of the hospital sink. In addition to the thorough disinfection of all stools, lime and dry earth should be thrown into the sinks. The possibility of flies gaining access to any fecal matter in the sinks should be absolutely prevented by this means. Attendants should be required to disinfect their hands after attending each patient in each instance.

The board especially recommends as an important sanitary measure that men with fever should be immediately removed from their regimental quarters or regimental hospital to the division hospital. Under no circumstances should the men with fever be permitted to occupy the tents with their comrades.

4. Camp sites.—Since it is true that every regiment in this division has been and is infected with typhoid fever, it follows that the ground upon which each and every regiment has been or is located is also infected. We therefore deem it very unwise to encamp a regiment upon sites vacated by those leaving. The tent floors left by the First Pennsylvania are now being used by the Sixth Virginia. This should not be done until these floors have been washed with a 5 per cent solution of carbolic acid and afterwards exposed to the direct rays of the sun for at least two days.

The foregoing recommendations are respectfully submitted.

WALTER REED,
Major and Surgeon, U. S. A.
VICTOR C. VAUGHAN,
Major and Division Surgeon, U. S. V.

The ADJUTANT-GENERAL SECOND DIVISION, FIRST ARMY CORPS,
Camp Poland, Knoxville, Tenn.

In extenuation of the condition of the camps at Chickamauga, it has been stated that all of the regiments there were on waiting orders, and expected every day that they would start the next for Cuba or Porto Rico. This is true, but it should not be offered in extenuation of the condition of the camps. Every camp, even when it is to be occupied for only a day, should be policed as thoroughly as if the commanding officer knew that he was to remain there for weeks.

Shelter, occupancy, and arrangement of camps.—On this point we will copy verbatim from the report of Lieutenant-Colonel Woodhull, who inspected the troops at Chickamauga in August:

All the troops are under canvas and nearly all the canvas is overcrowded. The tents are of many patterns—a few shelter, more conical and conical wall; some State tents of various sizes, the most of which are so-called "flood" tents of the Mississippi Valley, very old and nearly all leaky, and the greater part the improved common or A wall tent. The occupants vary from 2 in the shelter to 4 and 5 in the A, 6 or 8 in the "flood." and 15 or 16 in the conical.

Many of the regimental sites are precisely the same as those occupied from the beginning. A few of the regiments have been moved, and it is probable that more are now being changed, but at the time of my observation many of the commands had been in absolutely the same position for two months or more. Not only were the camp sites the same, but in the most instances the tents themselves stood where they had first been placed. In scarcely any instance was fresh ground available, as it should be, upon which the tents might be moved laterally every week or ten days. Consequently the ground itself is being poisoned imperceptibly but persistently by the human body without the disinfectant and redeeming action of direct sunlight upon it. The contents of the tents, such as blankets, straw, and the like, have been irregularly removed into the open air, but, as a

rule, not often enough. Direct touch showed in many instances that these articles and the ground were damp.

The camps, speaking generally, were crowded not merely as to inhabitants but as to the neighborhood. There was abundant room between divisions and generally between brigades, but many of the brigade camps were too compressed, and with some of the regiments the compression was extreme and in defiance of all sanitary laws; this in addition to the tents themselves having too many occupants. The difficulty probably arose originally from the expectation that many more troops would be sent into the park for whom space must be reserved. In some cases higher authority arbitrarily established the regimental lines. Whatever the reason, the effect is clear—the tents are overcrowded and without sufficient adjoining space, the streets are narrow, and the soil is becoming more and more charged with filth. Owing to reasons previously explained competent sinks were made with difficulty and were multiplied on account of their shallowness and the rapidity with which they filled with water. They thus encroached more and more upon the open space and intruded toward the camps. For instance, in the Second Arkansas, Second Brigade, Second Division, Third Army Corps, the men's sinks were within 30 yards of the kitchens, and were very offensive. The kitchen sinks were intermediate and so full and so foul that maggots were abundant on the surface. In the Fifth Pennsylvania the camp site was lower than the sinks, and during recent rains they overflowed and flooded the camp. The sick report of the regiment was 11 per cent, including 25 cases recognized as typhoid and 15 supposed to be of that disease, with the sick rate increasing.

More than half of the men slept on the ground. In some regiments the tents were floored, in others cots and field bedsteads were arranged, but always at private or regimental expense. The motive in many instances doubtless was comfort, but in one regiment (Third Tennessee) the men bought the cots because they had learned by experience in civil life that it was harmful to sleep on the ground in that climate. In a very sickly regiment (Ninth Pennsylvania) the medical officer pointed out a very high three-story bunk, whose tenants he declared the healthiest in the command. A group of three is too small to reason from, but it is significant that among much sickness these men escaped. The sanitary advantage of being off the ground is freedom from dampness, and especially escape from the immediate influence of the ground air, which under the conditions described must be peculiarly deleterious. It is recommended that in all camps of position in Southern climates the tents be floored, with a considerable space beneath, and that the floors be portable, so that they may be moved (within the camp) when necessary for change of site or for police. The expenditure for a few feet of lumber when the regiment departs is well balanced by the greater physical efficiency of the men.

Quite independently of any specific contamination of the water supply (and were the general water supply thus contaminated the typhoid fever would also be general, which it is not as yet), the pollution of the soil by fecal discharges, specifically diseased or healthful, leads to the occurrence of diarrhea, to general physical depression, moderate fever, and undermining the man's health, and whether an imported case or not is necessary to fire the train, it is the universal experience of armies that outbreaks of typhoid fever will occur under just such circumstances. This is perfectly understood and always anticipated by sanitarians where precautionary measures are not carried into effect. In this case, besides having a congenial soil fertilized day by day for such seed, the seed itself was introduced directly by various regiments, as Thirty-first Michigan, First South Carolina (as reported, regiment has left the park), Fifty-second Iowa, which brought no acute case but was infected before arrival, and Ninth Pennsylvania, which has had nearly 100 cases in all. Besides which, certain regiments (Fourteenth Minnesota, Second Ohio, Third United States Volunteer Cavalry)

have treated cases for considerable periods in the camps themselves. It can not be necessary to enlarge on the facilities for the spread of this disease that are afforded by fatigue, heat, moisture, overcrowding, dust, and flies, and all these are present.

The following figures give the most important facts concerning typhoid fever in the First and Third Army Corps:

FIRST ARMY CORPS.

[NOTE.—The regiments marked * went to Porto Rico.]

Commands.	Strength.	Total number of probable cases.	Percentage of troops with typhoid fever.	Number of recognized cases.	Total deaths.	Deaths from typhoid.	Percentage of deaths among probable cases.	Percentage of deaths among recognized cases.
FIRST DIVISION.								
First Brigade.								
*1st Kentucky	1,318	262	19.80	86	28	18	6.87	20.45
*3d Wisconsin	1,313	378	28.78	107	36	24	6.34	22.41
5th Illinois	1,296	125	9.64	113	16	8	6.04	7.08
Second Brigade.								
*4th Ohio	1,313				26	19		
*3d Illinois	1,321	546	41.33	149	44	25	4.57	16.77
*4th Pennsylvania	1,294				35	24		
Third Brigade.								
*16th Pennsylvania	865				40	34		
*2d Wisconsin	1,326	329	24.81	113	41	27	8.20	23.89
3d Kentucky	1,293	219	16.93	219	17	11	5.02	
SECOND DIVISION.								
First Brigade.								
31st Michigan	1,290	239	18.52	86	27	16	6.69	18.60
160th Indiana	1,312	223	16.99	47	11	8	5.58	17.02
1st Georgia	1,212	120	9.90	36	10	9	7.50	25.00
Second Brigade.								
158th Indiana	1,288	128	9.93	49	12	10	7.81	20.40
6th Ohio	1,299	291	22.40	148	21	19	6.52	12.83
1st West Virginia	1,298	260	20.03	106	15	12	4.61	11.32
Third Brigade.								
1st Pennsylvania	1,071	222	20.72	169	14	12	5.40	7.15
14th Minnesota	1,277	286	22.39	146	11	10	3.49	6.85
2d Ohio	1,297	403	31.07	192	14	13	3.22	6.77
THIRD DIVISION.								
First Brigade.								
5th Pennsylvania	1,291	338	26.18	152	16	16	4.73	10.52
12th Minnesota	1,299	433	33.33	144	19	19	4.38	13.19
1st South Carolina	1,163				20	10		
Second Brigade.								
8th Massachusetts	1,317	272	20.65	157	30	19	7.00	12.10
21st Kansas	1,264	294	23.25	95	23	21	7 14	22.10
12th New York	1,302	490	37.63	144	21	20	4.00	13.88
Third Brigade.								
2d Missouri	1,269	268	21.11	181	20	19	7.08	10.49
1st New Hampshire	1,269	297	23.40	213	32	30	10.00	14.13
9th Pennsylvania	1,291	334	25.87	155	28	26	7.78	16.77

THIRD ARMY CORPS.

Commands.	Strength.	Total number of probable cases.	Percentage of troops with typhoid fever.	Number of recognized cases.	Total deaths.	Deaths from typhoid.	Percentage of deaths among probable cases.	Percentage of deaths among recognized cases.
FIRST DIVISION.								
First Brigade.								
14th New York	1,277	233	18.24	95	31	24	10.30	25.26
1st Missouri	1,275	216	16.94	46	14	11	5.09	23.91
5th Maryland	985	250	25.38	147	18	17	6.80	11.56
Second Brigade.								
2d Nebraska	1,303	167	12.81	56	28	24	14.37	42.85
2d New York	1,014	161	15.87	46	31	30	18.63	65.21
1st District of Columbia	942	.....	.....	.....	25	14	.....	.....
Third Brigade.								
3d Tennessee	1,293	123	9.51	61	19	12	9.75	19.67
1st Vermont	996	278	27.91	84	26	22	7.91	26.19
8th New York	1,301	425	32.66	190	23	22	5.17	11.57
SECOND DIVISION.								
First Brigade.								
2d Kentucky	1,332	286	21.47	87	30	28	9.79	32.18
9th New York	1,292	323	25.00	139	46	46	14.24	33.09
1st Arkansas	1,290	228	17.67	83	23	19	8.33	22.89
Second Brigade.								
5th Missouri	1,274	212	16.64	51	16	14	6.60	27.45
2d Arkansas	1,291	287	22.23	95	26	17	5.92	17.89
69th New York	1,026	299	29.14	191	25	23	7.69	12.04
Third Brigade.								
1st Maine	1,286	188	14.61	88	45	45	23.93	51.13
52d Iowa	1,304	345	26.45	184	37	36	10.43	19.56
1st Mississippi	1,029	397	38.58	98	33	29	7.30	29.59
CAVALRY BRIGADE.								
3d U. S. Volunteer Cavalry	1,013	270	26.65	103	15	13	4.81	12.62
1st Illinois Volunteer Cavalry	1,299	220	16.93	68	17	16	7.27	23.52
1st Ohio Volunteer Cavalry	833	189	22.68	189	7	7	3.70	3.70
Light Artillery Brigade	1,893	.....	.....	.....	21	17	.....	.....
6th U. S. Volunteer Infantry	.....	133	.....	121	6	5	3.75	4.13

In the above tables the figures showing the strength of each regiment are not absolutely correct. In most cases the figures are those that indicate the strength of the regiment when it left Chickamauga. For the purposes for which these tables were compiled it would have been better if we could have given the total number of individuals connected with each regiment, but figures showing this fact are not at our command.

In coming to conclusions concerning typhoid fever among the troops of these corps, it will be necessary to leave out of consideration the seven regiments of the First Division of the First Army Corps that went to Porto Rico, because, as has already been stated, undoubtedly a considerable proportion of the cases of protracted fever in these

regiments were malarial, and from the data at our command we have been unable with any certainty to distinguish the malarial from the typhoid fevers in the cases originating in Porto Rico. From the death rate in these commands we believe that we have not overestimated the number of cases of typhoid fever in them. However, we think it best, on account of the uncertainty in the data among these regiments, to leave them out of consideration in making general statements concerning the statistics of typhoid fever in the First and Third Army Corps.

There were only two regiments (Fifth Illinois and Third Kentucky) of the First Division of the First Army Corps that did not go to Porto Rico.

These two regiments had a combined strength of	2,589
Total number of cases of probable typhoid fever in these two regiments	344
Percentage of probable typhoid fever among the troops of these two regiments	13.28
Total number of deaths from typhoid fever in these two regiments	19
Percentage of deaths among cases of probable typhoid fever in these two regiments	5.52

We can not give the total number of cases of recognized typhoid fever in these two regiments on account of having no data on this point for the Third Kentucky.

Aggregate strength of the Second Division of the First Army Corps	11,344
Total number of cases of probable typhoid fever in the Second Division of the First Army Corps	2,172
Percentage of probable typhoid fever among the troops of the Second Division of the First Army Corps	19.14
Total number of deaths from typhoid fever in the Second Division of the First Army Corps	109
Percentage of deaths among probable cases of typhoid fever in the Second Division of the First Army Corps	5.01
Total number of cases of recognized typhoid fever in the Second Division of the First Army Corps	979
Percentage of deaths among recognized cases of typhoid fever in the Second Division of the first Army Corps	11.13

In studying the Third Division of the First Army Corps, it will be necessary to omit the First South Carolina, which remained at Chickamauga only a few days.

Aggregate strength of the eight regiments of the Third Division of the First Army Corps	10,302
Total number of cases of probable typhoid fever in the eight regiments of the Third Division of the First Army Corps	2,726
Percentage of probable typhoid fever among the troops of the eight regiments of the Third Division of the First Army Corps	26.46
Total number of deaths from typhoid fever in the eight regiments of the Third Division of the First Army Corps	170
Percentage of deaths among probable cases of typhoid fever in the eight regiments of the Third Division of the First Army Corps	6.23

Total number of cases of recognized typhoid fever in the eight regiments of the Third Division of the First Army Corps	1,241
Percentage of deaths among recognized cases of typhoid fever in the eight regiments of the Third Division of the First Army Corps	13.69

In studying the First Division of the Third Army Corps, it will be necessary to omit the First District of Columbia Volunteers, because this command remained at Chickamauga only a few days.

Aggregate strength of the eight regiments of the First Division of the Third Army Corps	9,444
Total number of cases of probable typhoid fever in the eight regiments of the First Division of the Third Army Corps	1,853
Percentage of probable typhoid fever among the troops of the eight regiments of the First Division of the Third Army Corps	19.62
Total number of deaths from typhoid fever in the eight regiments of the First Division of the Third Army Corps	160
Percentage of deaths among probable cases of typhoid fever in the eight regiments of the First Division of the Third Army Corps	8.63
Total number of cases of recognized typhoid fever in the eight regiments of the First Division of the Third Army Corps	725
Percentage of deaths among recognized cases of typhoid fever in the eight regiments of the First Division of the Third Army Corps	22.06
Aggregate strength of the nine regiments of the Second Division of the Third Army Corps	11,124
Total number of cases of probable typhoid fever in the nine regiments of the Second Division of the Third Army Corps	2,565
Percentage of probable typhoid fever among the troops of the nine regiments of the Second Division of the Third Army Corps	23.05
Total number of deaths from typhoid fever in the nine regiments of the Second Division of the Third Army Corps	257
Percentage of deaths among probable cases of typhoid fever in the nine regiments of the Second Division of the Third Army Corps	10.01
Total number of cases of recognized typhoid fever in the nine regiments of the Second Division of the Third Army Corps:	1,016
Percentage of deaths among recognized cases of typhoid fever in the nine regiments of the Second Division of the Third Army Corps	25.29
Aggregate strength of the First and Third Army Corps, excluding the regiments that went to Porto Rico from the First Division of the First Army Corps, the First South Carolina from the Third Division of the First Army Corps, and the First District of Columbia Volunteers from the First Division of the Third Army Corps	44,803
Total number of cases of probable typhoid fever among these troops	9,660
Percentage of probable typhoid fever among these troops	21.56
Total number of deaths from typhoid fever among these troops	714
Percentage of deaths among probable cases of typhoid fever among these troops	7.40
Total number of cases of recognized typhoid fever among these troops	4,293
Percentage of deaths among recognized cases of typhoid fever among these troops	16.65

If to the above figures we add those of the Cavalry Brigade, we have the following:

Total number of troops in the First and Third Army Corps for which statistics concerning typhoid fever have been collected	47,948

Total number of cases of probable typhoid fever among these troops	10,339
Percentage of probable typhoid fever among these troops	21.56
Total number of deaths from typhoid fever among these troops	751
Percentage of deaths among probable cases of typhoid fever among these troops	7.26
Total number of cases of recognized typhoid fever among these troops	4,653
Percentage of deaths among recognized cases of typhoid fever among these troops	16.14

We are without sufficient data to enable us to add to the figures those from the Light Artillery Brigade and from the Sixth U. S. Volunteer Infantry.

We have used one statement in all of these compilations which, without proper explanation, may be misunderstood. We have given the percentage of deaths among recognized cases of typhoid fever. We have already called attention to the fact that the statement of this percentage is not altogether correct, because all the deaths from typhoid fever did not occur among recognized cases of typhoid fever. It may be of interest to inquire how the regimental and hospital surgeons diagnosed the cases which terminated fatally from typhoid fever. The 714 deaths given in the above figures as total deaths from typhoid fever in the First and Third Army Corps, excluding the regiments that went to Porto Rico from the First Division of the First Army Corps, the First South Carolina from the Third Division of the First Army Corps, the First District of Columbia Volunteers from the First Division of the Third Army Corps, and the Cavalry Brigade of the First Army Corps, were not all diagnosed typhoid fever by army medical officers. By looking over the list of deaths given in each regiment one easily sees that a considerable number of these deaths occurred after the patients had reached their homes on furlough. Most of these men sent home on furlough are recorded in the regimental and hospital reports as having malaria, or they were sent home without any definite diagnosis. Taking the 714 cases referred to, the recorded diagnoses of these cases were as follows:

Typhoid fever	391	Indigestion	4
Malaria	144	Gastritis	1
Undiagnosed, or undetermined fever	141	Enteritis	1
Diarrhea	22	Pneumonia	1
Dysentery	9	Total	714

In other words, in 4,293 cases of recognized typhoid fever among these troops 391 died. After studying the records we have added 5,367 cases which we believe to have been typhoid fever. Among the 4,293 cases of recognized typhoid fever there were 391 deaths; among the 5,367 cases which we have added there occurred 323 deaths from typhoid fever.

Percentage of deaths among the 4,293 cases of recognized typhoid fever	9.10
Percentage of deaths from typhoid fever among the 5,367 cases of probable typhoid fever	6.01

This, we think, is the strongest proof that we can offer that the cases which we have classed as probable typhoid fever are properly classified. The death rate among these *from* typhoid fever is the death rate *of* typhoid fever. As has already been stated, most of these men were allowed to go home on furlough. They were granted furlough on the diagnosis of some other disease than typhoid fever. They went to their homes, and 323 out of the 5,367 cases died from a disease recognized by the physicians who attended them in their last illness as typhoid fever. We think that these figures establish beyond any doubt our claim that the number of cases of typhoid fever among the troops in the First and Third Army Corps was more than twice the number recognized as having that disease.

Out of the 714 deaths from typhoid, 352 occurred in some army hospital; 315 occurred elsewhere, principally at the homes of the men, and in 47 cases we have not been able to ascertain the place of death. Parenthetically it might be remarked that these figures show that the general order permitting medical officers to send home sick men on furlough was not abused. The number of malingerers must have been very small. This was the opinion of the army medical officers at Chickamauga at the time. Frequently the statement was made that it was difficult to induce the men to accept furloughs until they became too sick to travel. All those who saw the sick returning from Chickamauga and other camps during the summer of 1898 must have been convinced by the appearance of these furloughed soldiers that they were in reality sick. The figures which we have just given confirm this impression with mathematical exactness.

We have several times spoken of the death rate of typhoid fever. It may be well to endeavor to ascertain what the death rate of this disease is. It is well known that ever since typhoid fever has been recognized as a distinct disease and has been distinguished from typhus fever the death rate from this disease has gradually decreased. This decrease in the death rate is undoubtedly due to two causes. In the first place, the diagnosis of the disease is much more easy than it was formerly when typhus fever was so prevalent; in the second place, the methods of treatment of typhoid fever have greatly improved. Murchison reported 2,505 cases that occurred in the London Fever Hospital from 1848 to 1862, with a death rate of 18.5 per cent; Griesinger collected 18,612 cases from the hospitals of London, Glasgow, Paris, and Strasburg from 1840 to 1865, and found a death rate of 18.52 per cent; in the Old Hospital in Vienna, from 1846 to 1861, there were 21,189 cases of typhoid fever, with a death rate of 22.2 per cent; in the Jacob's Hospital in Leipzig, from 1880 to 1893, there were 1,626 cases, with a death rate of 12.7 per cent; in the city of Hamburg, during the years 1886 and 1887, there were 10,823 cases, with a death rate of 8.5 per cent. These cases were divided by years as follows: In 1886, 3,948 cases, with a death rate of 9.2 per cent; in the year

1887, 6,875 cases, with a death rate of 6.9 per cent. In 1897 there were 1,885 cases at Maidstone, England, with a death rate of 7.5 per cent. Brand has collected 19,017 cases treated by cold baths, with a mortality of 7.8 per cent.

All the above given figures have been obtained from European sources and refer, many of them, to epidemics more or less remote in time. We have been anxious to ascertain the mortality from typhoid fever in this country and at this time. In order to get information on this subject we have addressed a request to the superintendents of several of the largest hospitals in the United States, asking for the number of cases of typhoid fever treated in the years 1896 and 1897, and the number of deaths in each of these years. We have not asked for cases in 1898, because we wished to avoid cases among soldiers. The following figures have been obtained in response to this request:

Death rate from typhoid fever in some of the larger hospitals in the United States.

Name of hospital.	Number of cases.		Deaths.		Total cases, 1896, 1897.	Total deaths. 1896, 1897.	Percentage of deaths.
	1896.	1897.	1896.	1897.			
City Hospital, Boston, Mass	437	399	44	46	836	90	10.76
Massachusetts General Hospital, Boston, Mass.	151	100	16	8	251	24	9.56
Episcopal Hospital, Philadelphia, Pa	153	141	13	10	294	23	7.82
University Hospital, Philadelphia, Pa	20	36	1	3	56	4	7.14
German Hospital, Philadelphia, Pa	64	153	7	10	217	17	7.83
Johns Hopkins Hospital, Baltimore, Md	110	116	11	3	226	14	6.19
St. Luke's Hospital, New York, N. Y	32	34	1	0	66	1	1.51
Bellevue Hospital, New York, N. Y	72	76	11	11	148	22	14.86
Mount Sinai Hospital, New York, N. Y	105	94	8	9	199	17	8.54

Total number of cases of typhoid fever in the hospitals	2,293
Total number of deaths among the cases treated in these hospitals	212
Percentage of deaths among these cases	9.24

It will be seen from these figures that the average death rate from typhoid fever in the large hospitals is a little more than 9 per cent. Bearing in mind that only graver cases are carried to hospitals, and that the cases treated in hospitals embrace all ages and conditions of life, while the soldiers were men selected on account of physical perfection, it must be admitted that a death rate of 7.49 per cent among the 10,339 probable cases of typhoid fever in the First and Third Army Corps was not an unusually low one.

We have endeavored to ascertain the death rate from typhoid fever in general practice in some of the largest cities of the Union. With this in view, we directed a letter to the health commissioner of each of these cities. Most of these officials replied that they are unable to give anything more than the number of deaths, inasmuch as cases of typhoid fever are not reported to the health authorities. From a few cities returns have been furnished us. In our opinion these are wholly worthless so far as information concerning the death rate from

typhoid fever is concerned. They are, however, of interest for another reason, and we will give some of them:

Death rate from typhoid fever in certain cities in the United States.

Name of city.	Year.	Number of cases.	Number of deaths.	Percentage of deaths.
Buffalo, N. Y	1894	1,088	185	17.00
	1895	397	98	24.68
	1896	274	68	24.81
	1897	201	63	31.34
	1898	280	98	35.00
Albany, N. Y	1896	438	97	22.14
	1897	440	84	19.09
Minneapolis, Minn	1896	435	60	13.79
	1897	1,534	148	9.64
Pittsburg, Pa	1896	1,216	175	14.39
	1897	1,284	184	14.33
Cleveland, Ohio	1896	296	142	47.97
	1897	256	73	28.51
Richmond, Va	1896	51	9	17.64
	1897	78	7	8.97
Duluth, Minn	1896	785	102	12.99
	1897	357	33	9.24
St. Louis, Mo	1896	348	106	30.45
	1897	433	124	28.63
Philadelphia, Pa	1896	2,490	402	16.14
	1897	2,994	401	13.38

Total number of cases of typhoid fever reported in the above-mentioned cities in 1896 and 1897 15,675

Total number of deaths among the cases reported in the above-mentioned cities in 1896 and 1897 2,659

Percentage of deaths among reported cases in the above-mentioned cities. 16.96

What information have we gained from these figures? Are we to infer from them that the death rate from typhoid fever in general practice in our large cities is 16.96 per cent, while in our hospitals, to which, as a rule, the graver cases are sent, it is only 9.24 per cent and while in the city of Hamburg it is only 8.5 per cent? In our opinion such inferences are not warranted. We are forced to conclude that in these cities in which the health regulations require physicians to report all cases of typhoid fever a large per cent of the cases of this disease are not recognized as typhoid fever. The army surgeon has been severely criticised for not recognizing typhoid fever. What can be said of the average physician in general practice in our country! We must call attention to the similarity in two sets of figures. Referring back to our percentage records concerning death from typhoid fever in the First and Third Army Corps, it will be seen that the percentage of deaths among recognized cases of typhoid fever was 16.65 per cent; now we have found that in the above-mentioned cities the death rate among recognized cases of typhoid fever is 16.96 per cent. In other words, the army surgeon did in his military service just as he was in the habit of doing in his civil practice—that is, he failed to properly diagnose the milder cases of typhoid fever. His military record on this point is no worse and no better than was his own record in civil practice, or is the record of physicians in some of the largest cities in the United States.

(NOTE.—Too late for insertion in this table we have received the following figures concerning typhoid fever in New York City:

Number of cases of typhoid fever treated in New York City during the year 1896	1,004
Number of cases treated during the year 1897	1,004
Number of deaths among those treated in 1896	297
Number of deaths among those treated in 1897	299
Percentage of deaths among those treated in 1896	29.64
Percentage of deaths among those treated in 1897	29.78
Total cases treated in New York City in 1896 and 1897	2,008
Total deaths among those treated in 1896 and 1897	596
Percentage of deaths among those treated in 1896 and 1897	29.71

Dr. Roger S. Tracy, register of records, sends the following statement with these figures:

"The 'cases treated' as given above are the cases reported to the department of health. It is not probable that all cases are reported, and there is no way of estimating the number that may go unreported. Of course all the deaths are included excepting the possible few cases that may be unrecognized and go upon the record under other names."

It will be seen from these figures that the physicians of New York City fail to recognize typhoid fever to a greater extent than did the army surgeons at Chickamauga.)

MALARIAL DISEASES IN THE FIRST AND THIRD ARMY CORPS.

As has already been stated, all kinds of illnesses were diagnosed malaria at Chickamauga. We find the most trivial cases, as well as the most serious ones, recorded as malaria. The medical officers apparently went into the southern camps believing that they would meet with this disease most frequently, and if we accept their recorded diagnoses their expectations were certainly fully realized. It will be interesting for us to make an inquiry concerning the actual prevalence of malaria among these troops. In the first place, it is worthy of note that in the regimental records themselves there is evidence that malaria was not a prevalent disease at Chickamauga Park. This evidence is furnished by such illustrations as the following: The Second Brigade of the Second Division of the First Army Corps consisted of the One hundred and fifty-eighth Indiana, the Sixth Ohio, and the First West Virginia. These regiments were encamped side by side. From the regimental sick reports it appears that malaria prevailed in the Indiana regiment from May throughout the summer; there were no cases in the Ohio regiment in May, 3 in June, 11 in July, 103 in August, and 203 in September; in the First West Virginia Regiment the diagnosis of malaria does not appear on the regimental records until August, when 108 cases are reported. That there should have been malaria in the Indiana regiment in May and not a case in either of the other regiments in the same brigade is not probable; and that it could have required two months for this disease, had Chickamauga been the fearfully malarious place it is said by some to be, progressing slowly through the Ohio regiment, to reach the West Virginia regiment is not in accord with any known

epidemiological facts concerning this disease. We think that such unequal distribution of the disease as shown by the above-mentioned records is proof quite convincing that malaria was not widely prevalent among the troops at Chickamauga. We have already seen that practically all of the prolonged malarias were actually cases of typhoid fever. Many of the temporary illnesses diagnosed as malaria may actually have been due to the plasmodium, but how many were due to this cause we can not positively state.

It is to be regretted that qualified men properly equipped were not placed earlier at all the national encampments, in order to make scientific diagnoses of malarial and typhoid fever. Scientific medicine would have been greatly enriched had this been done. As soon as we began the inspection of camps and hospitals we saw that it was absolutely necessary to provide for scientific diagnoses. In the division hospitals we found that most of the febrile cases were diagnosed as malaria. We believed that they were typhoid fever, but it seemed presumptuous in us to set our opinion above that of the very competent medical officers in attendance. We therefore asked the Surgeon-General that he should send competent men, properly equipped for making blood examinations for the malarial plasmodium and the Widal test to each of the large camps. The Surgeon-General acted promptly on this suggestion, and we are therefore able to give some scientific information concerning the actual prevalence of malaria.

At Sternberg Hospital, Chickamauga Park, Maj. R. Emmett Giffen, surgeon in command of the hospital, established a bacteriological laboratory and placed the same under the charge of Acting Asst. Surg. Charles F. Craig. The following is Dr. Craig's report of the work done in this laboratory:

REPORT OF THE BACTERIOLOGICAL LABORATORY TO NOVEMBER 1, 1898, STERNBERG UNITED STATES GENERAL HOSPITAL, CHICKAMAUGA PARK, GEORGIA.

Maj. R. Emmett Giffin,

Chief Surgeon, U. S. V., Commanding Hospital.

Sir: I have the honor to submit to you the following report regarding the work of the bacteriological laboratory up to the present date.

As it was your intention in establishing the laboratory to aid in the scientific study of the cases treated in the hospital and to investigate certain questions concerning the sanitary condition in Chickamauga, I have endeavored to follow your suggestions and orders as closely as possible.

I have had associated with me for a short time Acting Asst. Surg. George Dock, of Ann Arbor, Mich., a most competent and acknowledged authority upon the fevers of the South, especially malaria, and I have also been ably aided by Dr. James Jobling, whom you detailed to me as laboratory assistant.

The work in the laboratory has been divided as follows:

(*a*) The study of typhoid-fever cases, including post-mortem examinations and the use of Widal's test; (*b*) the examination of the blood of suspected cases for the plasmodium malariæ; (*c*) the bacteriological analysis of water; (*d*) the chemical and microscopical examination of urine, including the diazo-reaction; (*e*) the study of the blood of typhoid cases; (*f*) the study of cases of special interest.

(*a*) There have been ten post-mortem examinations made of subjects dead of typhoid fever, all of which demonstrated the pathological changes usually found in that disease. I have made several preparations illustrating very perfectly the changes occurring in the intestine, showing swelling, infiltration, ulceration, and perforation of Peyers patches, and swelling of the solitary glands.

Of special interest have been the results obtained by Widal's serum test in the typhoid cases in the hospital. I have examined to date 315 cases, using the Widal test, with the following results:

Of the 315 cases, 208 were diagnosed as typhoid fever, 5 as malaria, 13 as questionable typhoid, 20 as measles, 1 as typho malaria, 1 as simple fever, 1 as myalgia, 2 as pneumonia, 1 as cystitis, 1 as tuberculosis, 1 as questionable tuberculosis, 1 as thermic fever, 2 as dysentery, and 58 had no diagnosis.

Of the 208 cases diagnosed as typhoid, 205 cases reacted to Widal's test, while 3 did not; the latter cases, with the exception of one, have since proven not to be typhoid, while the one is still in doubt.

Of the 5 cases diagnosed malaria, 2 reacted to the test and were undoubtedly typhoid, while 3 did not react.

Of the 20 cases diagnosed as measles, not one reacted to the test.

Of the 13 cases diagnosed questionable typhoid, 7 gave reaction, while 6 gave no reaction.

One case diagnosed "typho malaria" gave a very marked reaction, and examition of the blood demonstrated that no plasmodia were present. This case was undoubtedly a straight typhoid.

One case diagnosed myalgia gave no reaction.

Two cases diagnosed dysentery reacted and proved to be typhoid.

One case diagnosed tuberculosis gave no reaction.

One case diagnosed tuberculosis gave reaction and proved to be typhoid.

One case diagnosed cystitis gave no reaction.

Two cases diagnosed pneumonia gave no reaction.

One case diagnosed thermic fever gave no reaction.

One case diagnosed "simple fever" gave a reaction and proved to be typhoid.

Of the 58 cases having no diagnosis, 30 reacted to the test, while 28 did not. Of the 28 which did not, 10 were too recent for the reaction to appear.

I have divided the reactions to the test as follows:

1. Character of reaction: Marked, 150 cases; medium, 58 cases; slight, 27 cases.

2. Time of reaction: Immediate, 95 cases; in five minutes, 64 cases: in ten minutes, 38 cases; in fifteen minutes, 25 cases; in twenty minutes, 8 cases; in twenty-five minutes, 6 cases.

The slowest reaction observed was complete within twenty-five minutes.

The earliest reaction was obtained upon the fourth day of the disease, the latest upon the sixtieth day. There were 5 reactions at the fourth day, 8 at the fifth, 10 at the sixth, 5 at the seventh, the remaining reactions ranging from the eighth to the fortieth day of the disease.

From the foregoing report it will be seen that the Widal serum test proved the diagnosis of typhoid fever in 99 per cent of the cases so diagnosed, there being 1 case still in doubt, and it further proved that at least 80 per cent of the sick in this hospital were suffering from typhoid fever. In cases other than typhoid the test gave a negative result of 100 per cent.

The Widal test has thus proved its great utility, and the results obtained in this laboratory conclusively show its great value as a diagnostic measure and its therapeutic use as indicating the treatment to be pursued in doubtful cases. Many of the reactions were very marked and demonstrated beautifully the inhibitory action of typhoid blood serum upon the movements of the bacillus of typhoid.

The cultures used in making the tests were twenty-four-hour cultures, obtained originally from pure cultures sent to the laboratory from the laboratory of the

United States Army Medical Museum and the laboratory of Johns Hopkins University.

(*b*) The examination of suspected cases for the malarial plasmodium has resulted in the demonstration of only 4 cases of malaria in this hospital since the laboratory was established.

Acting Asst. Surg. George Dock, during his work in this laboratory, demonstrated the tertian organism in 1 case, and since his departure I have found the quartan in 1 case, and the æstivo-autumnal in 2 cases.

(*c*) The bacteriological analysis of the water of Chickamauga Park has been carefully and steadily carried on, and I have already submitted to you three reports upon the examination of certain waters which you wished analyzed.

The results may be summed up as follows:

Samples of water from the following localities have been examined:

Chickamauga Creek, Intake spring; on Cave spring branch of creek, north well; first well south of north well; second well south of north well; Upper Ellis spring; Lower Ellis spring; Mullis spring; Kelly House well; Kelly field well; Brotherton well; the wells upon Snodgrass Hill road and Dyer House well; Blue spring, and Cloud spring.

The following water was found pure and fitted for domestic use: From Chickamaugua Creek, if filtered; north well, second well south of north well, Upper Ellis spring, Kelly House well, Kelly field well, Dyer House well, second well on Snodgrass Hill road, Blue spring. and Cloud spring.

The water from the following localities was condemned: Spring on Cave spring branch of Chickamauga Creek (contained B. coli. communis); first well south of north well, on Lafayette road (contained proteus vulgaris); Lower Ellis spring (too much bacterial life); Mullis spring (too much bacterial life); Brotherton well (too much bacterial life).

I have been unable to demonstrate the typhoid bacillus in any of the water examined.

(*d*) The work in urinary analysis has been divided into chemical, microscopical, and bacteriological.

The chemical examinations have been conducted by Dr. Jobling, about 200 samples having been analyzed.

The microscopical and bacteriological examinations, conducted by myself, have thus far shown nothing of special interest, unless it be the occurrence in the urine of typhoid cases of numerous bacteria, chiefly micrococci.

The diazo-reaction has been applied in a large number of cases, and, while always present in typhoid, it also occurred in other diseases.

(*e*) I have examined, bacteriologically, the blood of 12 cases of typhoid fever, and will submit to you shortly a special report concerning the conclusions arrived at.

(*f*) I have paid special attention to the study of individual cases, presenting special symptoms, and especially to those cases simulating the so-called "typho-malarial" fever of older writers. Within the last month I have found 2 cases of undoubted double infection, the plasmodium malariae and the typhoid bacillus being present at the same time in the same case. These cases are of great interest, and I will submit to you a special report concerning them, together with charts, etc.

The laboratory has been in operation only about five weeks, but its value has been proven, from a practical as well as a scientific standpoint, to the hospital, and has demonstrated the wisdom of your course in establishing it.

Had laboratory facilities been possible or available when the troops were first sent to the park, much of the sickness and distress which followed might have been prevented.

A special report regarding the relation of flies and other insects to the spread of typhoid fever will be submitted to you as soon as it can be prepared.

Respectfully submitted.

CHAS. F. CRAIG,
Acting Assistant Surgeon, U. S. A.

The following is a copy of the report of Professor Dock:

REPORT ON EXAMINATION OF BLOOD IN UNITED STATES ARMY HOSPITALS, SEPTEMBER, 1898, BY GEORGE DOCK, M. D., OF ANN ARBOR, MICH.

On September 7 I received orders to proceed to Sternberg Hospital, Chickamauga, Ga. Arriving September 9, I received every aid and encouragement from the chief surgeon, Maj. R. E. Giffin. I found that Acting Asst. Surg. C. F. Craig had fitted up a laboratory for bacteriological investigations, and must here express my thanks for the courtesy with which he put at my disposal all the apparatus and a place for working. I therefore lost no time in beginning my investigations. I soon discovered that many cases were diagnosed "malaria" without any obvious reason so far as the well-known clinical peculiarities of malarial disease are concerned and without any attempt at differential diagnosis between malaria and typhoid fever. In some wards many cases were diagnosed malarial, in others none. I went through one of these wards with the acting assistant surgeon in charge, but the "dozens of cases of typical malaria" he said he had were reduced to one doubtful case on examination of the history, temperature chart, and patient. Microscopic examination of the blood showed no parasites, and the Widal test was quickly positive. In this way a number of cases thought to be malarial were examined. In all, the blood was free from parasites; the Widal test positive. Having made all the examinations requested by the surgeons, I began a personal examination of the patients, going through each ward in order, examining all the fever cases, and making examinations of the fresh blood in all cases that seemed doubtful or otherwise important. In most of the cases quinine had been given, usually in large doses, up to 40 grains a day. This would have interfered with the examination in general, but inasmuch as the symptoms continued, the diagnoses were in some cases "continued malaria," "typho-malaria," or "mixed infection," and the surgeons in charge still adhered to the malarial character. Many examinations were made in such cases, always with negative results. Out of 65 cases in which the blood was examined[1] 5 had had no quinine at all, and 5 more had had none for several days before the examinations were begun. Among the former I included a case that had had one dose (0.6 gram) of quinine a few hours before the examination, and the only case in which parasites were found. This case was important in a number of ways. The notes are as follows:

Private McIntyre, Company H, Second Arkansas, ill five days with fever, slight chills, "pain all over," no nausea or vomiting. The bowels have been constipated. The tongue moderately large, the edge and tip rather red, the dorsum moist, with a thin white coat. The abdomen is retracted; pain in the epigastrium; there are no spots. The spleen can be easily felt an inch below the margin of the ribs; the edge is rounded and rather soft. The temperature on admission was 103.5°; it rose the same day to 104.3°; fell during the night to 101.5°; rose again to 104.2°,

[1] The comparatively small number of cases examined depends partly on the time spent in selecting promising cases out of a large number, often without temperature charts or histories, but more especially on the fact that in cases with negative results the examination is necessarily prolonged much beyond the time usually necessary to find germs in a positive case. In all examinations at least two good preparations were examined, and in some cases as many as ten examinations at different times.

remaining there for several hours; then fell to 99.5°; rose soon after to 99.8°, where it remained until next day, the fourth after admission. It then rose from about 8 a. m. and reached 105.3° at 4 p. m. In the afternoon there was a slight chill. The temperature fell slowly without sweating. The written diagnosis was typhoid fever. I saw the patient at 9.30 a. m. of this day, and being struck by the large size of the spleen, unusual at so early a stage in typhoid fever, examined the blood. I must say that the appearance of the patient was not unlike that of one in the early stage of typhoid fever. The temperature was 100.4°. I found large numbers of parasites, almost every field (one-twelfth inch oil immersion) containing one.

Most of them were in the small amœboid stage, from one-fourth to one-third the diameter of the red corpuscles, and with fine pigment grains. There were also a few parasites in a more advanced stage, almost filling the red cells, but without any signs of segmentation. The indications were that the patient had a double tertian infection, with one generation not numerous enough, in all probability, to produce a marked paroxysm. Soon after the examination the patient received a second dose of 0.6 gram of quinine, and the temperature fell to 98.5° at noon. Not knowing about the quinine at first, I was surprised to find the parasites disappearing about an hour after their discovery, and those present were in very slow motion. The temperature rose to 100.4°, then fell during the night to 98.5°, and remained below normal up to the time the patient was discharged ten days later. Parasites were found for two days after defervescence. They were rare the last time they were found and almost motionless. The subjective sensations improved with the fall of the temperature, and the patient remained well, having taken in all 1.2 grams of quinine (18.5 grains). (The patient said he had chills in Arkansas in the spring).

I have described this case rather fully because it seems of considerable importance in more than one respect. In the first place, it shows how a double tertian malarial infection may easily simulate typhoid for a short time. (It seems worth noting that the surgeon in charge, Acting Assistant Surgeon Pinckney, is familiar with malarial fever in Charleston, S. C.). More important is the fact that notwithstanding the peculiarity mentioned, a moderate dose of quinine at once cut the disease short, although, as is always the case, the organisms persisted for a short time after complete defervescence. From this fact and the ease with which recovery followed, it is not probable that the large number of cases diagnosed "malaria" were malarial alone, since almost all of them were treated with quinine, usually in larger doses than in this case. Many of them had from 1.5 to 2.5 grams daily for periods up to three weeks, without any notable effect on the temperature. On the other hand, it is quite probable a few cases of fever that appear in the reports were really of malarial nature. In a number of cases I obtained histories from men that seemed to have been malarial. But these rapidly recovered under the inevitable quinine. As a rule these patients were treated in quarters or in regimental hospitals, so that no charts were kept. I was unable to see any of these cases soon after defervescence while at Sternberg Hospital, but was more fortunate at Camp Meade.

The intensity of malarial infection in a locality like Chickamauga Park in summer can be estimated in general by the number of cases of simple intermittent fever observed. I know of no reliable statistics in the camp, but from my own investigations think the number must have been very small. I am confirmed in my belief by information kindly furnished by Maj. F. P. Robinson, surgeon of the Sixth U. S. Volunteers, who told me that in the two months his regiment was encamped in the park he had not had more than 6 cases of simple intermittent fever.

While the evidence for frequent malarial infection is therefore lacking, the clinical features of a very large proportion of the fever cases were those of typhoid

fever, not differing on the whole from that disease as seen in other parts of the country, as well as in Europe. In some cases the skin and mucous membranes showed evidences of lack of care (bedsore, multiple abscess, ulcers of the mouth). Some cases showed marked depression, sometimes perhaps due to the large doses of quinine or to other antipyretics, or to overdoses of whisky (half ounce every two hours from the time of admission). The course of the temperature in most cases was characteristic; the enlargement of the spleen was evident in many. The roseolar eruption was often present, but sometimes masked by innumerable spots due to flies and other insects. Blue spots I saw in three cases, in all of which lice had apparently been present, but were not when I saw the patients. The stools in most cases were quite characteristic. In all the blood examinations on uncomplicated cases I made the leucocytes were diminished, or at least not increased. The Widal test was made in a number of cases by myself, confirming or clearing up the diagnosis. This test was made on a most extensive scale by Acting Assistant Surgeon Craig, who will report his results.

In two cases I made autopsies on the bodies of patients dead of typhoid fever. I append brief notes:

Case 1.—Charles Kirk, musician, Company B, Fourteenth New York, 18 years old. Admitted to Sternberg Hospital September 5, in ward of Acting Assistant Surgeon Barnhart. Patient felt ill one or two days before admission. Diagnosis: Typhoid fever. Temperature, moderately high; marked delirium; for three days before death vomiting and involuntary discharge of watery stools. Died September 15, 1898. Examined one hour after death. No rigor mortis; slight lividity on the back; face dusky; muscles dry and dark red; no Zenker's degeneration. Lungs collapsed, slight hypostatic congestion of the left lower lobe; rest of lungs anemic; free from lesions. Pleuræ not diseased. Pericardium normal. Heart distended with fluid, dark blood; muscles firm and of normal appearance; valves normal. Spleen very large, estimated weight 1¼ pounds; capsule smooth, section dark red, anemic; Malpighian bodies distinct. Kidneys slightly enlarged, pale; cortex wide; parenchyma cloudy; Malpighian bodies prominent; pyramids anemic. Ureters negative. Bladder empty. The serosa of the ileum is red for about 2 feet above the valve. The appendix is red and swollen. The mesenteric glands are enlarged, red; those corresponding to the lower end of the ileum reaching the size of pigeon eggs. The mucous membrane of the stomach is red and ecchymosed. The ileum shows great swelling of the mucous membrane, folds being present all the way to the valve. The lower 5 feet of the gut show swelling of the solitary glands and Peyer's patches, the former reaching a diameter of 8 mm. Most of the lymphoid tissue is in the stage of medulary infiltration, but a few solitary nodules show superficial necrosis. The mucosa of the valve, the cæcum, and appendix are red and swollen. Two of the largest mesenteric glands contain necrotic foci. The liver is large, the surface rough, section pale, acini distinct; the consistency is tough; the capsule of Glisson increased. There are a few small grey areas on the section. Gall bladder full, not altered; the lymph glands at the neck are large and red.

Microscopic examination of the spleen pulp showed the absence of malarial pigment. Eberth's bacilli were cultivated from the spleen by Acting Assistant Surgeon Craig.

Case 2.—Private Pudil, Company H, Thirty-first Michigan. Acting Assistant Surgeon Norris. Patient came from Knoxville to visit relatives. While in ward was noticed by surgeon in charge, who found a temperature of 104° F. Patient was sick two weeks after that, having fever rarely less than 103.5° F., anxious and delirious all the time. September 11 there was a slight hemorrhage. September 15 complained of pain in the abdomen, which was found rigid. Diagnosis of perforation and peritonitis. Death September 16.

Autopsy showed slight hypostatic congestion of both lungs; spleen enlarged;

the lower end contained a hemorrhagic infarction 4 cm. in diameter. The peritoneum is red, swollen, and rough all over, containing about a quart of thin, yellow, watery fluid containing yellow flakes of fibrin, and in the pelvis a small amount of thin, yellow feces. The liver and spleen are also covered with thin fibrinous exudate. The serous surface of the lower part of the ileum is dark red or violet. About a foot above the cæcum is a perforation 2 by 4 mm. in diameter. The mesenteric glands are moderately enlarged. The mucosa of the ileum is moderately swollen. The Peyer's patches and solitary glands in the upper part of the diseased area are swollen, but with pitted, or reticulated, or gray surfaces. The Peyer's patches in the lower 3 feet of the ileum are ulcerated; some to the inner, some to the outer muscular coat, one, 2 cm. in diameter, to the serosa in a small part, without perforating. The perforating ulcer is 2.5 cm. in diameter. Some of the ulcers have thickened edges, some not; all are clean, and a large one just above the valve is covered with healthy granulations. The mucous membrane of the cæcum is swollen and of dark violet color. The left kidney contains an anæmic infarct 1 inch in diameter. The pelvis is red, swollen, and contains thin opaque mucous fluid. Bladder unaltered.

Microscopic examination of the splenic pulp shows absence of malarial pigment.

In Knoxville I examined the blood of 14 patients diagnosed as having malarial or "typho-malarial fever" In 1 case the diagnosis was "malarial jaundice," though the history pointed rather to acute indigestion, and there had been no actual icterus. Quinine had been used in all cases. The blood in all was negative. I saw a great many cases diagnosed malaria that were evidently typhoid, but all had taken quinine in large doses.

In the division hospital I became acquainted with a major and surgeon who had been making diagnoses of malaria ostensibly by the use of the microscope, both at Chickamauga and later at Knoxville. I was convinced that he was totally unable to recognize malarial parasites. Experts need only to be told, by way of proof, that in all cases he found the so-called parasites in large numbers, usually, as he said, in every red corpuscle. He demonstrated his inability to distinguish between red and white corpuscles in his own blood.

When I arrived at Camp Meade I found comparatively few cases with the diagnosis of malaria in the Second Division hospital. Most of the surgeons claimed that malarial disease was very rare there. I found two wards, the so-called malarial wards (3 and 4), in which a great many cases had the diagnosis of malaria. I examined the blood of many of these, also of many recently admitted men and some suspicious cases in the other wards, to the number of 20, but without finding any parasites. As the bacteriological outfit was incomplete, Widal tests could not be made, but out of the so-called malarial cases at least two-thirds were evidently typhoid in the middle stage, some not yet definitely recognizable and some convalescent. Some of the other cases appeared to be convalescent from malaria without typhoid manifestations.

In the First Division hospital I was told there were a great many cases of malaria and typho-malarial fever. Several so-called typical cases of the latter had no parasites and were evidently uncomplicated cases of typhoid fever. One case proved to be malaria, and is quite as instructive as the positive case found at Chickamauga.

Case 3.—Private Beyer, Company F, Fifteenth Pennsylvania, came two weeks before examination from Sheridan's Point, Va. Four days later he began to have chills, and had, so far as he knows, three chills, tertian (?). He felt quite well the free days. The temperature had not been taken often enough to give the type. There had been a chill the day before examination, and the patient had taken 24 grains of quinine in two days. Soon after beginning the examination I found an organism almost filling a red blood corpuscle. I thought the patient was nearing a paroxism, but on examining the preparation further I found no

other parasites in two very good covers. The temperature taken then was 98° F., and the patient felt well. He had no doubt recovered for the time being, furnishing another example of the ease with which such infections can be broken up. Like the case previously described, he came to camp already infected. As a matter of diagnostic interest it may be added that this was the only case among several hundred with fever examined by me with herpes on the lips.

To summarize, I found remarkably little evidence that malaria was prevalent in Sternberg Hospital, in Camp Meade, and in the division hospital at Knoxville, the only cases found having been imported.

Malarial infection was probably more common than the results of my blood examinations indicate, but was easily broken up, and malaria was an inconsiderable factor in the large number of fever cases that appear under various names in the hospital records of these camps.

I found no evidence of combined typhoid and malarial infection. Among so large a number of cases of typhoid fever in men from all parts of the country some cases of that kind must have occurred. The examinations of experienced observers, and especially of those who had opportunities for making autopsies in the city hospitals, to which many patients were sent with the diagnosis of "malaria," will be of great interest in this connection.

The nomenclature of fevers in the camps named was, on the whole, irrational and arbitrary.

GEORGE DOCK.

ANN ARBOR, MICH., *October 17, 1898.*

INTESTINAL DISORDERS IN THE FIRST AND THIRD ARMY CORPS.

Intestinal disorders were very common among these troops. It is safe to say that at least two-thirds of the officers and men at Chickamauga suffered more or less from some form of intestinal disturbance. These intestinal disturbances were recorded under different names according to the individual views of the surgeons in charge. Gastritis, gastro-enteritis, and enteritis seemed to have been favorite expressions under which many regimental surgeons recorded these cases. In some regimental records the above-mentioned terms appear almost to the exclusion of the word "diarrhea," while in other regiments nearly all of these cases were recognized as acute diarrhea, which certainly was the correct diagnosis. We have carefully searched the records and fail to find any evidence of the existence of a case of amœbic dysentery among these soldiers. In fact, true dysentery was certainly very rare. Most of the cases of intestinal disorder were diarrheas in which the lower part of the large intestine only was affected. In a few instances ulceration resulted. In most cases there was no elevation of temperature, and the men were excused from duty for from one to three days. We are inclined to attribute the diarrheas to infection with saprophytic germs brought from the sinks and deposited on the food by flies.

The relation of the intestinal disorders to typhoid fever is of considerable interest to us, and we have already gone somewhat extensively into this subject in the histories of the Sixth Ohio and the First West Virginia regiments. This matter is of sufficient importance to

justify us in inquiring into it further. In the first place it should be stated that the regimental surgeons followed no definite rules in their reports of intestinal disorders. Some of them evidently recorded every case reported to them, while others made record of only the more serious ones.

In the First Arkansas Volunteer Infantry 359 cases of diarrhea are recorded. In the same regiment there were 228 cases of probable typhoid fever. Sixty of the individuals who had typhoid fever had had some previous intestinal disturbance. We have already called attention to the fact that in many instances the preceding intestinal disorder was evidently a part of the typhoid process.

The following cases from this regiment are illustrations of this relation:

No. 1.—Dysentery August 15–18; typhoid fever August 20; furloughed August 21.
No. 2.—Diarrhea June 14–16; typhoid fever June 22; furloughed August 17.
No. 3.—Diarrhea August 2–6; typhoid fever August 14; furloughed August 23.
No. 4.—Dysentery August 5–10; gastritis, August 16–18; continued fever, August 19; died September 19.
No. 5.—Gastritis June 2–3; typhoid fever June 10.
No. 6.—Diarrhea July 7–10; typhoid fever July 31; died, August 9.
No. 7.—Diarrhea August 10–16; typhoid fever August 20.
No. 8.—Diarrhea May 30–31; dysentery June 2–3; typhoid fever June 16.
No. 9.—Diarrhea August 1–2; typhoid fever August 12.
No. 10.—Dysentery July 31 to August 3; typhoid fever August 16.
No. 11.—Diarrhea July 20–31; typhoid fever August 2.
No. 12.—Diarrhea June 7–10; typhoid fever July 3.
No. 13.—Diarrhea July 28–31; typhoid fever August 15.
No. 14.—Diarrhea July 26–27; typhoid fever August 16.
No. 15.—Diarrhea July 28–29; typhoid fever August 19.
No. 16.—Diarrhea August 29 to September 2; typhoid fever September 7.
No. 17.—Diarrhea July 29 to August 2; typhoid fever August 15.
No. 18.—Diarrhea August 6–12; typhoid fever August 16.
No. 19.—Diarrhea July 12–13; typhoid fever August 31.
No. 20.—Diarrhea May 30–31; diarrhea June 15–18; typhoid fever June 19.
No. 21.—Diarrhea June 8–11; typhoid fever June 24.
No. 22.—Diarrhea June 6–7; typhoid fever June 12.
No. 23.—Gastritis August 19–20; typhoid fever August 23.

It is possible that in all of these cases the intestinal disorder that preceded the typhoid fever occurred about the time of the typhoidal infection. We are inclined to believe that in many of those instances the infection was a mixed one and that the effect of this mixed infection was a diarrhea.

Of the 228 cases of probable typhoid fever in the First Arkansas Volunteer Infantry, 168 had no illness, so far as the record shows, preceding the typhoid fever; in other words, 73.68 per cent of the cases of typhoid fever were not preceded by any recorded intestinal disorder, while 26.32 per cent of the cases of typhoid fever were preceded by some intestinal disorder. However, in 23 out of the 60 cases which

were preceded by some intestinal disorder the preceding intestinal disorder was probably due to the typhoid infection.

In the Fifty-second Iowa Volunteer Infantry there are recorded 691 cases of diarrhea, and there were in this regiment 345 cases of probable typhoid fever; 99 of the cases of probable typhoid fever were preceded by some recorded intestinal disorder. Of these the following may be of interest:

No. 1.—Diarrhea August 13–18; typhoid fever August 24.
No. 2.—Diarrhea August 2–8; typhoid fever August 15.
No. 3.—Diarrhea August 14–17; typhoid fever August 18.
No. 4.—Diarrhea August 26–30; typhoid fever September 7.
No. 5.—Diarrhea August 2–3; typhoid fever August 11.
No. 6.—Diarrhea July 9–10; typhoid fever July 25.
No. 7.—Diarrhea July 11–13; typhoid fever July 20.
No. 8.—Diarrhea August 20–22; typhoid fever August 28.
No. 9.—Diarrhea July 31 to August 4; typhoid fever August 19.
No. 10—Diarrhea August 20–26; typhoid fever August 30.
No. 11.—Diarrhea August 13–17: indigestion August 18–20; typhoid fever August 20.
No. 12.—Diarrhea August 21–27; typhoid fever August 30.
No. 13.—Diarrhea August 4–5; typhoid fever August 16.
No. 14.—Diarrhea August 19–20; typhoid fever August 21.
No. 15.—Diarrhea July 20–22; diarrhea July 24–25; typhoid fever July 29.
No. 16.—Diarrhea July 30 to August 18; typhoid fever August 31.
No. 17.—Diarrhea August 20–22: typhoid fever August 24.
No. 18.—Diarrhea August 15–19; typhoid fever August 26.
No. 19.—Diarrhea July 9–16; typhoid fever August 3.
No. 20.—Diarrhea August 19–24; typhoid fever August 30.
No. 21.—Diarrhea August 11–12; typhoid fever August 13.
No. 22.—Diarrhea July 3–4; diarrhea July 9–16; diarrhea July 23–26; typhoid fever August 13.
No. 23.—Diarrhea August 13–14; typhoid fever August 31.
No. 24.—Diarrhea July 5–6; typhoid fever July 15.

We believe that in these cases it is more than probable that the preceding intestinal disorder resulted from a mixed infection, from which typhoid fever developed later. The following summary will show the principal facts concerning the relation between typhoid fever and intestinal disorders in this regiment:

Number of cases of intestinal disorder	691
Number of cases of probable typhoid fever	345
Number of cases of probable typhoid fever not preceded by any recorded intestinal disorder	246
Percentage of cases of probable typhoid fever not preceded by any recorded intestinal disorder	71.30
Number of cases of probable typhoid fever in which the preceding intestinal disorder probably had some relation to the subsequent typhoid fever	24

In the Second Missouri Volunteer Infantry 400 cases of intestinal disturbance are reported, while the number of probable typhoids was 168; 47 individuals appear on both of these lists. In the following

cases a direct relation between the preceding intestinal disorder and the typhoid fever is regarded as probable:

No. 1.—Diarrhea July 1–10; typhoid fever July 14.
No. 2.—Diarrhea September 6–7; typhoid fever September 8.
No. 3.—Diarrhea June 7–8; diarrhea, June 17–20; typhoid fever June 28.
No. 4.—Diarrhea August 15–17; typhoid fever August 30.
No. 5.—Diarrhea September 2–5; typhoid fever September 8.

The following summary will show the principal facts concerning the relation between typhoid fever and intestinal disorders in this regiment:

Number of cases of intestinal disorder	400
Number of cases of probable typhoid fever	168
Number of cases of probable typhoid fever not preceded by any recorded intestinal disorder	121
Percentage of cases of probable typhoid fever not preceded by any recorded intestinal disorder	72.02
Number of cases of probable typhoid fever in which the preceding intestinal disorder probably had some relation to the subsequent typhoid fever	5

In the Ninth New York Volunteer Infantry the number of cases of diarrhea was 497, while the cases of typhoid fever numbered 323; 73 individuals appear on both of these lists. In the following cases it is probable that the preceding intestinal disorder had some relation to the typhoid fever:

No. 1.—Intestinal colic July 30–31; typhoid fever August 21.
No. 2.—Diarrhea July 30–31; typhoid fever August 3.
No. 3.—Gastritis July 15–20; typhoid fever July 26.
No. 4.—Diarrhea July 5–6; typhoid fever July 10.
No. 5.—Diarrhea August 21–28; typhoid fever September 10.
No. 6.—Diarrhea July 2–5; typhoid fever July 9.
No. 7.—Diarrhea August 8–9; typhoid fever August 19.
No. 8.—Diarrhea August 12–13; typhoid fever August 30.
No. 9.—Gastritis July 30 to August 1; typhoid fever August 7.
No. 10.—Dysentery August 27–29; typhoid fever August 30.
No. 11.—Diarrhea June 9–12; typhoid fever June 29.
No. 12.—Diarrhea July 2–3; diarrhea July 6–8; typhoid fever July 19.
No. 13.—Intestinal colic June 1–2; typhoid fever June 10.
No. 14.—Diarrhea July 18–29; typhoid fever July 30.
No. 15.—Gastro-duodenitis July 1–2; typhoid fever July 28.
No. 16.—Gastro-enteritis August 2–8; typhoid fever August 17.
No. 17.—Diarrhea July 29–31; typhoid fever August 4.
No. 18.—Diarrhea August 28–30; typhoid fever September 5.
No. 19.—Indigestion June 5–6; typhoid fever June 14.
No. 20.—Diarrhea August 18–20; typhoid fever September 1.
No. 21.—Diarrhea July 10–11; typhoid fever July 20.
No. 22.—Diarrhea June 25–26; typhoid fever July 6.
No. 23.—Diarrhea August 23–28; typhoid fever September 3.
No. 24.—Diarrhea August 13–16; typhoid fever August 20.
No. 25.—Diarrhea July 16–17; typhoid fever July 18.
No. 26.—Diarrhea August 22–23; typhoid fever August 24.
No. 27.—Diarrhea July 25–27; typhoid fever July 30.
No. 28.—Intestinal colic July 12–17; typhoid fever July 18.

The following summary will show the principal facts concerning the relation between typhoid fever and intestinal disorders in this regiment:

Number of cases of intestinal disorder	497
Number of cases of probable typhoid fever	323
Number of cases of probable typhoid fever not preceded by any recorded intestinal disorder	250
Percentage of cases of probable typhoid fever not preceded by any recorded intestinal disorder	77.39
Number of cases of probable typhoid fever in which the preceding intestinal disorder probably had some relation to the subsequent typhoid fever	28

In the Sixty-ninth New York Volunteer Infantry the number of cases of recorded diarrhea is less than the number of cases of probable typhoid fever. This is the only regiment in which we found this to be the case. The number of diarrheas recorded amounts to 205, while there are 299 cases of probable typhoid fever; the number of individuals whose names are found in both of these lists is 57. In the following cases there is probably some relation between the preceding intestinal disorder and the typhoid fever:

No. 1.—Diarrhea June 19–20; typhoid fever July 9.
No. 2.—Gastritis October 2–12; typhoid fever October 16.
No. 3.—Dysentery September 20–27; typhoid fever October 1.
No. 4.—Dysentery September 19–30; typhoid fever October 11.
No. 5.—Diarrhea July 20–24; typhoid fever July 24.
No. 6.—Gastritis September 13–18; typhoid fever September 18.
No. 7.—Dysentery July 19–24; typhoid fever August 8.
No. 8.—Dysentery September 26 to October 1; typhoid fever October 11.
No. 9.—Dysentery July 28–29; typhoid fever August 3.
No. 10.—Dysentery August 2–8; typhoid fever August 17.
No. 11.—Diarrhea July 17–18; typhoid fever July 20.
No. 12.—Diarrhea July 18–21; typhoid fever July 30.
No. 13.—Dysentery October 13–19; typhoid fever October 23.

The following summary will show the principal facts concerning the relation between typhoid fever and intestinal disorders in this regiment:

Number of cases of intestinal disorder	205
Number of cases of probable typhoid fever	299
Number of cases of probable typhoid fever not preceded by any recorded intestinal disorder	222
Percentage of cases of probable typhoid fever not preceded by any recorded intestinal disorder	74.24
Number of cases of probable typhoid fever in which the preceding intestinal disorder probably had some relation to the subsequent typhoid fever	13

In the Eighth Massachusetts Volunteer Infantry 2,250 cases of intestinal disorder and 272 cases of probable typhoid fever are recorded; the names of 109 individuals are common to both of these lists. In

the following cases the preceding intestinal disorder is regarded as having some relation to the typhoid fever:

No. 1.—Gastro-enteritis August 20–28; gastro-enteritis September 1–13; diarrhea October 11–15; sent to Fort Thomas with typhoid fever October 24. There can be but little doubt that this man was convalescing from typhoid fever when sent to Fort Thomas and that the initial date of this disease should be given as August 20.

No. 2.—Gastro-enteritis August 30 to September 1; typhoid fever September 7.

No. 3.—Diarrhea August 8–26; typhoid fever September 3.

No. 4.—Gastro-enteritis September 10–15; typhoid fever September 27.

No. 5.—Gastro-enteritis August 21–26; typhoid fever September 7.

No. 6.—Gastro-enteritis September 10–17; typhoid fever September 23.

No. 7.—Diarrhea August 15–16; typhoid fever August 23.

No. 8.—Gastro-enteritis September 9–13; gastro-enteritis September 19–22; typhoid fever September 23.

No. 9.—Gastro-enteritis August 27 to September 1; typhoid fever September 4.

No. 10.—Diarrhea August 9–15; diarrhea August 30 to September 4; typhoid fever September 25.

No. 11.—Diarrhea August 10–16; typhoid fever August 17.

No. 12.—Diarrhea July 16–22; typhoid fever July 23.

No. 13.—Gastro-enteritis September 11–13; gastro-enteritis September 19–21; gastro-enteritis September 27–30; typhoid fever October 8.

No. 14.—Gastro-enteritis September 5–9; typhoid fever September 24.

No. 15.—Gastro-enteritis September 8–12; typhoid fever September 20.

No. 16.—Gastro-enteritis September 15–24; typhoid fever October 3.

No. 17.—Gastro-enteritis August 9–14; typhoid fever August 30.

No. 18.—Acute diarrhea August 9–14; typhoid fever August 19.

No. 19.—Gastritis September 18 to October 24; gastritis October 24 to November 4; typhoid fever November 5.

No. 20.—Gastritis October 11–13; gastritis October 15–20; typhoid fever November 2.

No. 21.—Gastritis September 5–12; typhoid fever September 29.

No. 22.—Gastritis September 19–20; typhoid fever September 28.

No. 23.—Diarrhea August 26–28; gastro-enteritis September 2–17; gastro-enteritis September 19–25; typhoid fever October 8.

No. 24.—Gastro-enteritis August 31 to September 6; gastro-enteritis September 19–25; typhoid fever October 5.

No. 25.—Gastro-enteritis September 6–11; typhoid fever September 11.

No. 26.—Gastro-enteritis September 30 to October 2; typhoid fever October 5.

No. 27.—Gastro-enteritis September 27–30; typhoid fever October 5.

No. 28.—Gastro-enteritis September 10–18; typhoid fever October 3.

No. 29.—Gastro-enteritis September 10–15; typhoid fever September 24.

No. 30.—Gastro-enteritis August 22–26; typhoid fever September 5.

No. 31.—Gastro-enteritis August 26 to September 1; gastro-enteritis September 9–13; gastro-enteritis September 15–30; typhoid fever October 7.

No. 32.—Diarrhea August 4–6; typhoid fever August 9.

No. 33.—Gastro-enteritis September 14-16; typhoid fever September 16.

No. 34.—Gastro-enteritis September 9–13; typhoid fever September 13.

No. 35.—Diarrhea August 11–12; gastro-enteritis August 13 to September 6; diarrhea September 7–8; diarrhea September 8–20; gastro-enteritis September 27 to October 5; convalescing from typhoid fever November 5.

No. 36.—Diarrhea September 7–8; typhoid fever September 14.

No. 37.—Diarrhea August 13–16; typhoid fever August 16.

No. 38.—Diarrhea August 14–15; typhoid fever August 18.

No. 39.—Gastritis August 19–22; typhoid fever August 23.

No. 40.—Gastro-enteritis August 28 to September 5; gastro-enteritis September 5–14; typhoid fever September 29.

No. 41.—Gastro-enteritis August 27–28; typhoid fever September 4.

No. 42.—Diarrhea August 13–14; gastro-enteritis August 20 to September 15; typhoid fever September 29.

No. 43.—Gastro-enteritis August 27–28; typhoid fever September 1.

No. 44.—Gastro-enteritis September 6–8; typhoid fever September 8.

No. 45.—Gastritis August 27 to September 2; typhoid fever September 3.

No. 46.—Gastro-enteritis September 28 to October 7; typhoid fever October 7.

No. 47.—Gastro-enteritis August 31 to September 5; typhoid fever September 5.

No. 48.—Diarrhea August 9–14; typhoid fever September 6.

No. 49.—Diarrhea August 9–10; diarrhea August 11–18; typhoid fever September 3.

No. 50.—Diarrhea August 19–22; diarrhea August 27 to September 1; typhoid fever September 4.

No. 51.—Diarrhea August 27–28; typhoid fever August 29.

No. 52.—Diarrhea August 31 to September 2; typhoid fever September 2.

No. 53.—Gastro-enteritis September 4–12; typhoid fever September 12.

No. 54.—Gastro-enteritis August 22–26; gastro-enteritis August 30 to September 2; gastro-enteritis September 4–15; typhoid fever September 15.

No. 55.—Gastro-enteritis September 1–18; typhoid fever September 19.

No. 56.—Gastro-enteritis September 16–22; gastro-enteritis September 27 to October 7; typhoid fever October 14.

No. 57.—Gastro-enteritis September 21–28; typhoid fever October 11.

No. 58.—Gastro-enteritis September 4–11; typhoid fever September 11.

It will be seen that in many of the above given cases the preceding intestinal disorder could not have been other than a part of the typhoid fever itself. The following summary will show the principal facts concerning the relation between typhoid fever and intestinal disorders in this regiment:

Number of cases of intestinal disorder	2,250
Number of cases of probable typhoid fever	272
Number of cases of probable typhoid fever not preceded by any recorded intestinal disorder	163
Percentage of cases of probable typhoid fever not preceded by any recorded intestinal disorder	59.9
Number of cases of probable typhoid fever in which the preceding intestinal disorder probably had some relation to the subsequent typhoid fever	58

In the Second New York Volunteer Infantry 822 cases of intestinal disorder and 161 cases of probable typhoid fever are recorded; the names of 56 individuals appear upon both of these lists. In the following cases there is most probably some relation between the preceding intestinal disorder and the typhoid fever:

No. 1.—Acute diarrhea July 12–13; typhoid fever August 4.

No. 2.—Diarrhea July 15–17; typhoid fever August 8.

No. 3.—Diarrhea August 3–6; typhoid fever August 12.

No. 4.—Diarrhea August 1–7; typhoid fever August 20.

No. 5.—Diarrhea July 21–22; typhoid fever August 14.

No. 6.—Indigestion August 12–14; typhoid fever August 20.

No. 7.—Diarrhea July 16–17; typhoid fever August 8.
No. 8.—Diarrhea July 9–10; diarrhea July 18–19; typhoid fever August 5.
No. 9.—Indigestion August 22–24; typhoid fever August 29.
No. 10.—Diarrhea July 20–21; typhoid fever July 26.
No. 11.—Diarrhea July 16–17; diarrhea July 20–23; typhoid fever July 31.
No. 12.—Diarrhea July 28 to August 2; typhoid fever August 20.
No. 13.—Diarrhea July 31 to August 1; typhoid fever August 15.
No. 14.—Diarrhea July 3–9; typhoid fever July 10.

The following summary will show the principal facts concerning the relation between typhoid fever and intestinal disorders in this regiment:

Number of cases of intestinal disorder	822
Number of cases of probable typhoid fever	161
Number of cases of probable typhoid fever not preceded by any recorded intestinal disorder	105
Percentage of cases of probable typhoid fever not preceded by any recorded intestinal disorder	65.21
Number of cases of probable typhoid fever in which the preceding intestinal disorder probably had some relation to the subsequent typhoid fever	14

The relation of the intestinal disorders to typhoid fever became more prominent as the season advanced. The intestinal disorders of May and June very infrequently show any relation to typhoid fever, while those of July and August frequently show such a relation. Apparently the diarrheas of May and June had no protective influence against subsequent infection with typhoid fever, while there can be but little doubt that the diarrheas of July and August did show such a protective influence. We have already suggested an explanation for this in our discussion of the history of the Eighth New York. Since writing that part of the report, we have gone minutely into the history of other regiments, and the opinion expressed at that place has been confirmed by our subsequent studies.

Our conclusions concerning the relation between intestinal disorders and typhoid fever among the troops of the First and Third Army Corps may be summarized as follows:

(1) A large proportion (averaging at least 75 per cent) of the cases of typhoid fever were not preceded by any intestinal disorder.

(2) In a fair proportion of the cases of typhoid fever which were preceded by some intestinal disorder it is more than probable that the preceding intestinal disorder resulted from saprophytic germs taken into the body simultaneously with typhoid germs. The effects of the saprophytic germs were shown almost immediately and manifested themselves in some intestinal disorder, while the effects of the typhoid germs did not appear until later.

(3) We are inclined to the opinion that in these cases the difference in time between the appearance of the intestinal disorder and the development of the subsequent typhoid fever represents the period of incubation of the latter disease. If this supposition be true, the period of incubation varies from two days to three weeks.

(4) The intestinal disorders of May and June very infrequently had any relation to typhoid fever.

(5) The intestinal disorders of July and August frequently gave temporary immunity against typhoid fever.

(6) Typhoid fever was in a large proportion of the cases of that disease, due to a mixed infection. It is probable that in many of the cases in which this mixed infection, occurred, the diarrhea induced by the saprophytic microorganisms so thoroughly removed the specific germs of typhoid fever that the individual did not develop the latter disease and did acquire, for the time being at least, a certain degree of immunity to typhoid fever.

(7) We certainly are justified in concluding that the intestinal disorders among these troops did not predispose the individuals affected by them to typhoid fever.

CHAPTER VII.

TYPHOID FEVER IN THE SECOND ARMY CORPS, CAMP ALGER, VA.

Site.—This camp, which was selected as a rendezvous for the Second Army Corps, commanded by Maj. Gen. W. H. Graham, U. S. Volunteers, is located $7\frac{1}{4}$ miles west of Washington, D. C., and about $6\frac{1}{2}$ miles south of the Potomac River.

Topography.—We have been unable to procure a detailed topographical map of the site of Camp Alger. We have been informed by Lieut. Col. James L. Lusk, U. S. Volunteers, chief engineer, Second Army Corps, that preparations for a map of this kind were well advanced, but that the want of time and the press of other duties prevented its completion.

The point occupied as headquarters is elevated 408 feet above the Potomac River and was the highest point in the camp site. The average elevation of the regimental camp sites above the Potomac River was about 300 feet.

The general surface of the camp site is decidedly undulating, being well provided with open spaces for regimental or brigade encampment and interspersed with native forests.

By consulting the map of this camp site it will be seen that it is traversed by a few small brooks and provided with a number of shallow springs.

Geological formation and water supply.—We are indebted to Lieutenant-Colonel Lusk, U. S. Volunteers, for valuable information concerning this camp site, and from whose letter we quote the following:

> The layer of soil is quite thin and is underlaid by a stratum of very impervious clay. * * * This stratum of clay appears to extend well down toward the rock, being generally separated from the latter by a layer of fine sand, generally

called "quicksand" by the drillers. With a few exceptions this rock, of the gneiss family, is covered by a layer of so-called "rotten rock," which grew harder downward.

Although at first the shallow springs already referred to, and neighboring farm wells were depended upon as a source of water supply, it was soon clearly seen that other means would have to be provided to meet the urgent demands for a better and purer supply of water. An attempt had been made to anticipate this want on the part of a few regiments by ordinary dug wells located in their own regimental camps.

As there were no bathing facilities, the men, in most instances, were marched to the small branches of Accotink Creek, several miles away, or to the Potomac River, still more distant.

On May 25, 1898, the first troops having arrived on May 18, an artesian well was completed in the neighborhood of the camp of the Sixth Massachusetts and the Eighth Ohio regiments. This well supplying a fair yield of soft, clear, and palatable water, the pressure for others of the kind in different parts of the camp became very great.

A board appointed by the War Department reported, on June 2, 1898, in favor of other artesian wells for each regiment, or a series of wells from which the water could be pumped to the regimental camps. The first of these plans was adopted, and we are informed that about June 5 additional drilling machines were sent to the camp by the Quartermaster's Department, and that the sinking of the wells was ordered to be prosecuted as rapidly as possible until there should be one for each regiment. This work was under the immediate supervision of the chief engineer of the Second Army Corps. By reference to the map of this camp site, the date on which these wells were completed, as well as their depth and height above the Potomac River, may be ascertained.

We here again quote from Lieutenant-Colonel Lusk's letter:

> During the formative period of the camp the regiments arrived in rapid succession, before any corps headquarters had been established or corps staff organized. Many thousand men were thus gotten into camp grounds of insufficient area, with no water supply except from a few ordinary dug wells, springs, and small streams. The streams became at once polluted and unfit for use. The few wells and springs affording an insufficient supply even for drinking and cooking, relief was sought by digging shallow wells or sinking driven wells of small depth, using small pipe, both classes of wells being sunk in the regimental camps, or by excavating holes in wet ground and forming so-called springs. The relief thus obtained was precarious so far as concerns quantity, as the water was sure to fail upon the advent of dry weather.

We may state that this demand for a better water supply was not fully met, notwithstanding the most energetic action on the part of the chief engineer officer, until about the end of June.

General location of regimental camp sites.—These were, as a general rule, well selected and had good natural drainage, being situated on

knolls, mostly cleared, but sometimes on wooded hillsides. In a number of instances, however, they were unnecessarily limited in area.

Lieut. Col. Charles Smart, deputy surgeon-general, U. S. Army, having completed an inspection of Camp Alger, Va., states, under date of July 13, 1898, at which time a number of the regiments had already occupied their camp sites for nearly two months, as follows:

> The striking characteristics of the camps of the First Division were overcrowding of tents on the camp site, overcrowding of men in the tents, dust, sun glare, and fetid odors. The Eighth, Twelfth, and Thirteenth Pennsylvania were packed closely together, with scarcely an interval between the regiments, the company streets hardly wider than the intervals between adjacent companies should have been. Tents of the same companies in contact with each other on the sides and of adjacent companies in contact by the ends.

These regiments constituted the Third Brigade of the First Division, and probably presented the worst overcrowding to be found among any of the brigades encamped at Camp Alger. The condition of affairs in the First Brigade, First Division, was only slightly better, except that the Sixty-fifth New York Infantry, belonging to this brigade, had more space.

According to Lieutenant-Colonel Smart, the regimental camps of the Second Division were generally more expanded than those of the First Division.

Disposition of garbage and excreta.—Garbage was deposited in open pits near the kitchen, and sinks were placed at varying distances beyond the garbage cesspools.

Referring to the regiments of the First Division, Lieutenant-Colonel Smart again says:

> The kitchens were close up against the company tents, with uncovered cesspools for kitchen slops and garbage, and the sinks were also so close that although some care was given to covering the deposits with earth, the sink odor pervaded the company streets.

We may state that during the months of June and July this condition of cesspools and sinks was common to all the organizations brought together at this camp site. Their contents were left much of the time uncovered, even during the dry weather prevailing in June, and their condition was rendered still more intolerable after the advent of wet weather, since, owing to the high level of the ground water, the contents of the sinks floated to the surface, and could not be covered without filling in the pits.

Tentage.—At the time of our inspection of Camp Alger, Va., beginning August 20, 1898, the several regiments constituting the First Division of the Second Army Corps, together with the three other regiments belonging to a separate brigade, were all supplied with all necessary tents, but the latter were unprovided with any flooring. This condition as to sufficient tentage did not characterize the earlier days of

Camp Alger, since, according to the best available testimony, some of the regiments arrived with too little tentage for their full strength, and hence the men were, for a time, too much crowded together in the tents.

Rainfall and temperature.—Before taking up the medical history of individual regiments, especially the occurrence of typhoid fever in these, we may state that very dry weather prevailed during the latter part of May and the month of June, and that it was not until about the 20th of July that the first heavy rainfall occurred at Camp Alger. This amounted to 1.1 inches. On the 28th day of June there was a fall of rain amounting to 0.7 of an inch. During the latter part of July and until the middle of August, there were repeated heavy rainfalls; but the weather was dry during the last half of August and the first half of the month of September, at which time the camp was abandoned.

As regards the temperature, the weather was extremely hot, and this condition prevailed practically during the whole encampment. (See Meteorological Chart, Camp Alger.)

First Division.

Commands.—Sixty-fifth New York Infantry, Seventh Ohio Infantry, First New Jersey Infantry, Sixth Illinois Infantry, Sixth Massachusetts Infantry, Eighth Ohio Infantry, Eighth Pennsylvania Infantry, Twelfth Pennsylvania Infantry, Thirteenth Pennsylvania Infantry, Third Virginia Infantry, First Connecticut Infantry, Troops A and C, New York Cavalry.

GENERAL DISCUSSION.

A careful examination of the regimental histories, which have been given above at some length, serves to bring out a number of salient features.

In the first place, it will be seen that some of the regiments in the First Division, while yet in their State encampments, had one or more cases of typhoid fever, and that the majority of these organizations, upon their arrival at Camp Alger, imported at least 1 case of this disease into the Virginia camp.

We will have occasion to point out more than once the probability, in assembling 1,000 men in any part of the United States, that typhoid fever will appear among them within the period of incubation after their rendezvous.

We find that the following regiments of the First Division, Second Army Corps, imported typhoid fever into the camp at Camp Alger: Sixty-fifth New York, 1 case; Seventh Ohio, 1; Sixth Massachusetts, 1; Sixth Illinois, 1; Eighth Pennsylvania, 1; Third Virginia, 2.

The following regiments imported no case: First New Jersey, Eighth Ohio, Twelfth Pennsylvania, Thirteenth Pennsylvania, First Connecticut.

We do not think that the importance of keeping before us this fact of the importation of typhoid fever by regimental organizations can be too much emphasized, since, in a number of cases, this early importation has been overlooked by the regimental medical officer, and since this may serve as a focus of infection for other cases of this disease. As regards this division of the Second Army Corps, however, in the majority of instances, the disease having been recognized by the regimental surgeon, the soldier was promptly transferred to the general hospital at Fort Myer, Va., a point remote from the camp.

Another point to which we desire to direct attention is the considerable time which elapsed between the arrival of the several regiments at Camp Alger and the occurrence of the first case of typhoid fever in these organizations. This is shown by the following table:

Regiment.	Date of arrival.	Date of occurrence of first case of typhoid fever at Camp Alger.
65th New York	May 20	June 15
7th Ohio	May 21	June 14
1st New Jersey	do	July 2
6th Massachusetts	May 22	June 16
6th Illinois	May 21	June 20
8th Ohio	May 19	July 12
8th Pennsylvania	May 18	June 25
12th Pennsylvania	May 19	June 26
13th Pennsylvania	do	June 20
3d Virginia	June 5	June 22
1st Connecticut	July 19	Aug. 5

The Third Virginia Infantry and the First Connecticut Infantry developed their first case in a shorter time than the other regiments. This, so far as regards the last-named regiment, is readily to be referred to the fact that this organization arrived at Camp Alger at a period when the camp was already thoroughly infected with typhoid fever.

Another fact worthy of notice is the small number of cases which are recorded for the period ending June 30, at which time nine of the regiments belonging to this division had been in camp on an average of forty days. (The Third Virginia and First Connecticut, attached to this division but not brigaded, did not arrive until June 5 and July 19, respectively.)

We find the distribution of the cases of typhoid fever for this period as follows: Sixty-fifth New York, 2; Seventh Ohio, 1; First New Jersey, none; Sixth Massachusetts, 9; Sixth Illinois, 2; Eighth Ohio, none; Eighth Pennsylvania, 2; Twelfth Pennsylvania, 2; Thirteenth Pennsylvania, 1; Third Virginia, 2 (imported, 2 others).

It will thus be seen that with the exception of the Sixth Massachusetts no regiment had more than 2 cases during this period. The latter regiment arrived on May 22, had its first case on June 2, followed by a second and third case on June 16 and 18. We note also that 4

of the 9 cases in this regiment were confined to Company H, and that 6 of the companies of this regiment had no case up to the time of their departure from Camp Alger, July 5, so that this particular regiment is an exception to the rule. The explanation is not hard to find, since this regiment was constantly on provost duty from the time of its arrival at Camp Alger, and hence the men were subjected to additional danger of infection.

In order to show that the performance of provost duty gives better opportunity for typhoid fever infection, we may cite the course of typhoid fever in Troops A and C of the New York Cavalry Squadron, which occupied an excellent camp site near corps headquarters. This organization, numbering 6 officers and 199 enlisted men, arrived at Camp Alger on May 23, and imported 2 cases of typhoid fever, 1 on May 30 and 1 on June 1, both of which cases were promptly transferred to the general hospital at Fort Myer. This organization was principally used for provost duty, and notwithstanding the fact that its water supply was derived from a deep well or was imported, as Hygeia, Apollinaris, and such waters, and that the well water was boiled, we observe that 4 additional cases of typhoid fever appeared during the month of June, unquestionably due to duties which would call them away from camp and thus expose them to various sources of infection in the surrounding country.

When we take into consideration the nature of the water supply at this camp during the latter part of May and a considerable part of the month of June and the chances for water pollution, we think it particularly surprising that so few cases of typhoid fever can be traced among this division numbering more than 12,000 men. The same remark will apply still more forcibly to the Second Division of the Second Army Corps during this period. This, to our minds, points unmistakably to the absence of sources of infection at Camp Alger during this time, and indicates clearly that these were sporadic cases contracted by the men during their absence from the camp, in the city of Washington and vicinity.

Lieutenant-Colonel Smart, deputy surgeon-general, U. S. Army, under date of July 13, 1898, reports as follows:

> These camps, notwithstanding their many unsanitary factors, are unusually free from disease. Vaccinia, measles, a few venereal cases from proximity to Washington, and some diarrheas from irregularities of diet or from chill after perspiration and the difficulty of attending to personal comfort in the crowded tents, constitute the sick list. In addition to these, I found that since the camp was established in May 39 cases of typhoid fever had been reported and sent to hospital for treatment. Four occurred during the month of May, 23 in June, and 12 up to the date of my inspection, in July. Taking the month of June as the second month of the aggregation of troops and rating the strength of Camp Alger during that month as 20,000, the fever rate for the month would be 1.15 cases per 1,000 men.

As a matter of fact, Colonel Smart, relying upon the testimony of the regimental medical officers, reported fewer cases of typhoid fever up to July 13, 1898, than had actually occurred.

After the most careful search, we have been able to trace up to the 30th of June, a period of about forty days since the establishment of the camp, excluding imported cases, 21 cases of this disease among the regiments of the First Division and 11 cases among those constituting the Second Division; total, 32.

Basing the calculation upon the mean strength of the First Division for the month of June, namely, 11,137, we find 1.88 cases of typhoid fever per 1,000 men. Taking the mean strength of the Second Division for the month of June, namely, 11,257, we find only 0.97 per 1,000 men. The ratio for both divisions for the period ending June 30 is 1.42 per 1,000 men.

If we take the period ending July 15, we find that 71 cases of recognized typhoid fever have occurred in the First Division and 32 cases in the Second Division, or a total of 103 cases, as against 39 cases reported by Colonel Smart for the period ending July 13, or a ratio of 4.06 per 1,000 men in a mean strength, for both divisions, of 25,341. The ratio of the First Division alone for this period, based upon the mean strength for July, viz, 13,135, is 5.40; and that for the Second Division alone, also based on the mean strength for July, viz, 12,206, is 2.62 per 1,000 men.

It will thus be seen that typhoid fever had made but slight progress in both divisions of the Second Army Corps up to the period ending June 30, but that during the succeeding fifteen days, constituting the first half of July, the disease had slowly but steadily increased to the extent of 4.06 per 1,000 men.

Returning to the First Division which, all things taken into consideration, was placed in less favorable circumstances than the Second Division, we observe that contamination of the general water supply at a period when this supply was most questionable and most subject to contamination does not appear to have occurred, since we find that up to June 30 of the 110 company organizations, including 1 hospital corps company, constituting this division at that time, 92 companies had had no case of typhoid fever, although the water supply was the same for all companies in each regiment. In other words, only 18 company organizations in this division had experienced cases of typhoid fever up to the 30th day of June.

We desire to call attention, however, to the fact that, notwithstanding the absence of contamination of the general water supply, the occurrence of 32 sporadic cases of typhoid fever among these 18 company organizations, constituting so many foci of infection internal to this division, was pregnant with meaning for the further spread of the disease. It was just at this time that a better, purer, and more abundant water supply had been obtained through the sinking of a bored well for each regiment; but notwithstanding this purer water supply, typhoid fever continued to increase. These wells were of the artesian class and varied in depth from 47 feet to 156 feet, only 5 out of 40 wells being less than 60 feet in depth.

In boring for water a layer of very impervious clay of varying thickness was met with. Below this was found a layer of rock into which the hole was drilled until a satisfactory yield of water was secured. Simultaneously with the boring of the well a wrought-iron pipe was driven downward by repeated falls of a heavy weight until, when rock was reached, a water-tight joint was made by driving the pipe until its cutting edge practically refused to go further.

We can well believe the statement of Lieutenant-Colonel Lusk, chief engineer, to whom we are indebted for the foregoing information concerning the construction of these wells, when he states that, in his opinion, "these artesian wells were not subject to surface contamination, owing to the method of constructing them and the character of the strata through which they passed." He further adds:

> The water supply in each case appeared to come from the extreme bottom of the well and to have no connection with the ordinary veins found at slight depths.

We may here state that following close upon our inspection of this division during the latter part of August, 1898, we subjected the samples of water from the wells of the Eighth, Twelfth, and Thirteenth Pennsylvania Infantry, of the Ninth Ohio Battalion, of the well at corps headquarters, and of the house well near the latter, to careful bacteriological examination, and were unable to isolate the colon bacillus from any of these sources except in the case of the house well, which was practically an open well, liable to contamination from air dust. These wells were all located in the old camps of the First Division, which were occupied until the beginning of August.

We also had careful bacteriological examinations made of the water from all the wells in the new camp of this division and were able to isolate a microorganism resembling the colon bacillus in two instances, namely, from the well of the First New Jersey and First Connecticut Infantry.

Notwithstanding the purity of the water supply, therefore, and contrary to the generally accepted opinion on the part of the medical profession, we find that typhoid fever having been imported into various, although few, company organizations of this division, now steadily advanced; so that, as compared with the first fifteen days of July, when only 50 cases of typhoid fever were recorded for this division, we find during the second half of this month not less than 131 cases of this disease have occurred, and that the number of company organizations affected increased from 18 to 35 out of a total of 74 companies at that time constituting the First Division.

The escape from the occurrence of typhoid fever of more than one-half of the companies of this division (39) still points unmistakably to the absence of contamination of the general water supply.

The only exception to the freedom from water contamination is in the case of Company G, Twelfth Pennsylvania Infantry. By reference to the individual history of this regiment above given, it will be seen that there is strong evidence pointing to the infection of the shal

low well constructed by the men of this company, owing to close proximity to the battalion privy. It will further be observed that the large number of cases occurring in this particular company strongly contrasts with the few that occurred in the companies of other regiments of this division.

At this period, July 31, when cases of typhoid fever had occurred in 47 per cent of the company organizations of the First Division, we find, notwithstanding change of camp sites made by the several regiments during the last few days of July or the first week in August, and in spite of much attention given to camp sanitation, the disease made steady and rapid progress during August as compared with the month of July. Thus, we find in a mean strength of 9,464 for August, there occurred 326 cases of recognized typhoid fever in this division, or 34.44 cases per 1,000 of strength.

If we turn to the course of this disease in the several brigades of this division, we find that the number of cases per 1,000 men rises in the First Brigade, composed of the Sixty-fifth New York, Seventh Ohio, and First New Jersey, to 48.17; in the Third Brigade, composed of the Eighth, Twelfth, and Thirteenth Pennsylvania, to 32.63; while in the two regiments not brigaded, consisting of the Third Virginia and the First Connecticut, it was 17.36 per 1,000 men. It will be recalled that from the well water of the last-mentioned regiment a bacillus was isolated which somewhat resembled the colon bacillus. (No calculation is made for the Second Brigade, as this had left for service in Porto Rico on the 5th day of July.)

The highest rate per 1,000 men was attained in the case of the Sixty-fifth New York Infantry, in which, in a mean strength of 1,315 men for August, there were 123 cases of recognized typhoid fever, or 93.53 per 1,000. This regiment therefore leads all of the regiments in the First Division as regards prevalence of the disease.

Before referring to the individual record of this regiment, it will be seen that during the month of July there occurred 24 cases of typhoid fever, 16 of which were confined to Company E. It will further be seen that prior to its removal from its old camp site to a new and higher camp on August 8 there had occurred 26 additional cases of typhoid fever, and that within twelve days following its change of camp site there were 44 additional cases which could be attributed to infection in the old camp. Even after the lapse of this period, however, the disease continued unchecked, since we find 53 cases occurring during the last eleven days of August. There could be no doubt, therefore, that the majority of the companies of this regiment were pretty well infected with typhoid fever prior to the change of camp site and that the sources of infection, probably individual to the companies, continued in the new camp.

We may here state that at the time of our inspection of this regiment, on the 23d day of August, 1898, we found 16 men on an average

in each conical wall tent and no provision made for flooring the tents. In a number of tents inspected by us bedding, clothing, together with other articles, were in contact with the ground and thoroughly covered with dust and dirt. If tent infection, which we will discuss in another part of this report, is concerned in the spread of typhoid fever, then all of the necessary conditions were present in this regiment for the propagation of the disease in this manner.

We here recall that at the time of our inspection our attention was invited to the fact that the location of the well of the Sixty-fifth New York in the camp occupied by it during the latter half of June, July, and the first week of August was such as to receive the surface drainage from the entire First Brigade. Our own inspection verified this undesirable location of the well. It does not follow, however, that the water of this well became contaminated so as to constitute a factor in the spread of typhoid fever in this regiment, since we find that of the 12 companies, all of which were making free use of the water, Companies C and K had no cases of typhoid fever during July or the first week in August, while Companies D, G, and I had during July and the entire month of August, respectively, only 4, 7, and 4 cases. Indeed, typhoid fever in this regiment was largely confined during August to Companies A (12), B (11), C (16), E (9), F (25), and L (15). We have not therefore hesitated to exclude this well as the source of regimental infection.

The inspection of the camp of the Sixty-fifth New York made by the board was followed by a like inspection of the several camp sites of the regiments constituting the division. As a result of this inspection, we were gratified to find that much care was being given to camp sanitation, such as the general police of the camp site and the disposition of the garbage and excreta, although the latter, in the majority of regiments, was by no means satisfactorily carried out. In all sinks we were able to observe fecal matter exposed to the access of large numbers of flies. An exception to this statement was found in the case of the Twelfth Pennsylvania Infantry, which regiment was located in a camp to itself near Dunn Loring Station. Here we found that, by the direction of the colonel commanding, each privy vault was guarded by a regularly posted sentinel, whose duty it was to compel each soldier to cover his stool with earth as soon as deposited. Not only was this effectually carried out, but upon leaving the sink the soldier was compelled to thoroughly wash his hands with soap and water provided for that purpose.

We here note that in spite of change of camp site and the enforcement of better sanitary police, typhoid fever did not markedly decrease in this regiment until the beginning of the fourth week in August, the camp site having been changed on August 2.

During the last two days of August and the early part of September the First Division of the Second Army Corps abandoned Camp

Alger, Va., the eight regiments constituting the division at that time taking their departure as follows: Twelfth Pennsylvania, August 29; Eighth Pennsylvania, August 30; Thirteenth Pennsylvania, August 31; Seventh Ohio, September 1; First New Jersey, September 2; Sixty-fifth New York, September 4; First Connecticut, September 7; Third Virginia, September 8.

All these regiments, except the Eighth, Twelfth, and Thirteenth Pennsylvania Infantry, left for their State encampments and for muster out of the service of the United States. The Twelfth Pennsylvania remained at Camp Meade, Pa., only until September 19, when it also left for muster out of service. The Eighth and Thirteenth Pennsylvania Infantry remained at Camp Meade as a part of the garrison stationed at that point, and later were transferred to Camp Mackenzie, Augusta, Ga.

The subsequent course of typhoid fever in these several regiments following their departure from Camp Alger has already been set forth in the individual histories of these regiments and need not here be further referred to, except to state that whenever the transfer of the regiment was followed by enforced sanitary measures typhoid fever slowly but steadily decreased; or where the regiment already infected with typhoid fever remained at its State encampment for a period of ten or more days, as in the case of the First Connecticut Infantry, the number of cases of typhoid fever rapidly increased, owing, as we think, to new sources of infection having been established during this time.

We have made no reference thus far to the course of typhoid fever in the Second Brigade of the First Division, since this brigade, consisting of the Sixth Massachusetts, Sixth Illinois, and Eighth Ohio Infantry, left Camp Alger on July 5, 1898, for service in Porto Rico and Cuba.

The Eighth Ohio Infantry arrived at Santiago, Cuba, on July 13. By consulting the individual history of this regiment it will be seen that one case of typhoid fever was admitted on July 12, and hence points to infection prior to the departure from Camp Alger. Owing to lack of data no definite knowledge can be obtained concerning the further occurrence of typhoid fever in this regiment, except that given in its history before mentioned.

In the case of the Sixth Massachusetts Infantry and the Sixth Illinois Infantry we find that these regiments were quartered on the U. S. S. *Yale* from July 8 to July 25, and that in the former regiment, it having become infected with typhoid fever prior to departure from Camp Alger owing to provost-marshal duty, not less than 49 recognized cases of typhoid fever occurred during the month, the majority of the cases having originated on the voyage from Charleston, S. C., to Guanica, P. R.

The Sixth Illinois Infantry had already had 2 cases of typhoid fever

during June at Camp Alger, but appears to have largely escaped the disease during the voyage to the island of Porto Rico, since we have only found 6 recognized cases of typhoid fever for the month of July. The subsequent history of typhoid fever in this regiment is given in its individual history.

Second Division.

Commands.—Twenty-second Kansas Infantry, One hundred and fifty-ninth Indiana Infantry, Third New York Infantry, Seventh Illinois Infantry, Sixth Pennsylvania Infantry, Fourth Missouri Infantry, Ninth Ohio Battalion, Third Missouri Infantry, First Rhode Island Infantry, Second Tennessee Infantry, Hospital Corps Company.

GENERAL DISCUSSION.

In considering the origin and course of typhoid fever in the Second Division we desire to call attention to the remarkable exemption from this disease which the several regiments of this division experienced in their State encampments. No case of typhoid fever appears to have actually occurred in any of these regiments prior to their arrival at Camp Alger, Va., and only two, namely, the Sixth Pennsylvania, encamped at Mount Gretna, Pa., and the Second Tennessee, encamped at Nashville, Tenn., imported each 1 case of typhoid fever into the Virginia camp.

In the Sixth Pennsylvania, which arrived at Camp Alger, Va., on May 19, we find a case of typhoid fever admitted from Company K on May 29 and transferred to the general hospital at Fort Myer, Va., where the diagnosis was confirmed.

In the Second Tennessee, which arrived on May 29, we find that a case of typhoid fever was admitted from Company G on the same date.

We deem it worth observing that 6 of the regiments of the Second Division were assembled at or near western cities, and that only 3 were assembled near Eastern or Southern cities.

Of the latter, typhoid fever was imported into Camp Alger by 2, namely, the Sixth Pennsylvania and Second Tennessee Infantry.

We have already referred to the fact that the regimental camps of this division were less crowded for space than those of the First Division, and that up to the period ending June 30 only 11 cases of typhoid fever had occurred in the Second Division.

Taking the mean strength of this division for the month of June, namely, 11,257 men, we find a rate of only 0.97 cases of typhoid per 1,000 men. This must be considered as a remarkably low rate of sickness from typhoid fever when we remember that this regiment had already been encamped at this station an average of thirty-four days, and this, too, during a period when the water supply was obtained from various sources—brooks and springs—regarded by the regimental medical officers as of decidedly questionable character.

No stronger evidence could be brought against the theory of water contamination than the fact that for the period ending June 30, of the 113 company organizations constituting the Second Division, only 10 companies had experienced 1 or more cases of typhoid fever, and these companies were a part of 6 different regimental organizations.

By referring to the occurrence of typhoid fever in the First Division as compared with the Second Division, it will be seen that the typhoid rate per 1,000 men for the same period was 1.88, or nearly double that given for the Second Division, and if we continue the comparison during the period ending July 31 we find that the occurrence of typhoid fever in the Second Division at Camp Alger, Va., still remained less than in the First Division, namely 10.8 per 1,000 men, as compared with 15.2 for the First Division. We observe, however, that the comparative rate of increase is practically the same for both divisions.

Foci of infection having by the end of June become internal to this division, we find, just as we did in the First Division, a slow but steady increase in the number of cases of typhoid fever, which rises from 11 cases during the month of June to 135 cases for July; and we note further that all of the regiments have now become infected. In other words, the sources of infection being both internal and external to the camp, the chances for infection were much multiplied; hence we find by the 31st day of July the number of company organizations in which typhoid fever had occurred has increased from 10 to 59, leaving still 54 company organizations, distributed among all of the regiments of this division, which were as yet unaffected by the disease. These noninfected companies, it must not be forgotten, were obtaining their water supply from the general regimental supply.

We have already shown that during the month of August, while the First Division still remained at Camp Alger, although occupying new camp sites, typhoid fever had continued to increase rapidly, reaching a rate of 34.44 per 1,000 men. During the same month the regiments of the Second Division, which had occupied, with a single exception, their original camp sites from May 19 to July 31, were placed under different conditions, inasmuch as they took their departure from Camp Alger on August 3 (Ninth Ohio excepted) and began a march to Thoroughfare Gap, via Bull Run and Bristow Station, Va. This march, which was begun during extremely hot weather, was terminated six days later, when the regiments went into camp at Thoroughfare Gap, where they remained for a period of about two weeks. At the end of this time the division was transported by rail to Camp Meade, Pa.

As this division was ordered from Camp Alger by reason of the prevalence of typhoid fever in its several regiments, it remains to be seen what good was attained in this respect from the march through Virginia to the encampment at Thoroughfare Gap. The following

table will show the number of cases which occurred in each regiment of this division during July and August:

Regiment.	July.	August.	Regiment.	July.	August.
22d Kansas	4	22	9th Ohio Battalion	2	6
3d New York	20	105	4th Missouri	17	30
159th Indiana	16	45	2d Tennessee	12	25
7th Illinois	11	39	3d Missouri	16	46
6th Pennsylvania	6	20			
1st Rhode Island	27	51	Total	131	389

During the same time, in addition to the 389 cases of recognized typhoid fever, there were 146 cases of probable typhoid fever recorded as occurring among the regiments of this division. Deducting 6 cases of recognized typhoid fever in the Ninth Ohio Battalion, which organization did not accompany the Second Division on its march through Virginia, we find a balance of 383 cases of typhoid fever in a mean strength of 12,164 men, equivalent to 31.48 cases per 1,000 men.

If we compare the number of cases of typhoid fever occurring in the regiments of this division during the first fifteen days in August, and which may be considered as infections prior to departure from Camp Alger, and those recorded for the last half of August, we obtain the following results:

Regiment.	Aug. 1–15	Aug. 16–31	Regiment.	Aug. 1–15	Aug. 16–31
22d Kansas	7	15	3d Missouri	21	26
159th Indiana	24	21	1st Rhode Island	20	31
3d New York	48	57	2d Tennessee	13	12
6th Pennsylvania	9	11			
7th Illinois	15	24	Total	165	217
4th Missouri	8	20			

Since the cases, 217 in number, occurring during the latter half of August may be considered as infections acquired en route to Camp Meade, Pa., it will be plainly seen that this division not only failed to shake off typhoid fever, but even experienced an increase of this disease. We can now readily see that this was due to the fact that the division, after marching for six days, went into a more or less permanent camp at Thoroughfare Gap, Va., and as each regiment was already badly infected, there was no reason why the disease should not continue to be propagated in increased numbers. Indeed, the very object for which this march was begun was effectually defeated by the stay of the division at Thoroughfare Gap for a period of from ten to fourteen days. We do not doubt that if, instead of camping at this place, it had been possible to continue the march until the middle of August, typhoid fever would have been, to a large extent, eradicated from the several regiments. From a sanitary point of view, the transference of this division by rail from Thoroughfare Gap, Va., to Camp Meade, Pa., was a mistake, since each of the regiments carried their infection with them, and hence we are not surprised to

find that many cases of typhoid fever still continued to occur after arrival at the latter camp.

The subsequent history of the course of typhoid fever in this division will be found in the individual histories of these regiments, as well as under the head of typhoid fever at Camp Meade, Pa.

It remains to discuss briefly the occurrence of typhoid fever among the men of the Hospital Corps companies at Camp Alger, Va., since the members of this corps came into more intimate contact with the subjects of typhoid fever than the men of the regimental organizations.

We have already seen that during the month of June there were only 1.42 cases of typhoid fever per 1,000 men in both divisions of the Second Corps. During the same period no case of typhoid fever was recorded among the men of the Hospital Corps. We begin to appreciate during July, however, the danger involved in the personal handling and nursing of typhoid fever cases, especially by nurses who were ignorant of the danger of infection, for while the ratio of cases per 1,000 men for the two divisions reaches only 4.06, there were 15.3 cases per 1,000 men among the members of the Hospital Corps. These ratios rise to 25.6 per 1,000 men for August, 60.54 for September, 53.84 for October, and even during November, when but few cases of typhoid fever were occurring in the Second Army Corps, not less than 7 per 1,000 of the men of the Hospital Corps were still sick with typhoid fever. During this period there were 89 cases of recognized typhoid fever and 18 probable cases in a mean strength of 575 men. We have been able to record 8 deaths among the recognized cases, a mortality of 8.88 per cent.

Since the hospital corps was divided into three companies of about 200 men each and placed under the best sanitary surroundings nothing could point more strongly to the danger of personal contact with those sick with typhoid fever than the foregoing ratios of morbidity. Failure to carry out careful disinfection of excreta and neglect of hand disinfection after contact with cases of the disease were unquestionably the important factors in the propagation of the infection.

In striking contrast to the high percentage of cases of typhoid fever in the hospital corps may be mentioned the course of the disease amongst the 200 men constituting the signal corps company, with a record of only 6 cases of typhoid fever for the period May 30 to December 31, 1898.

Separate Brigade, Third Division.

Commands.—Ninth Massachusetts Infantry, Thirty-third Michigan Infantry, Thirty-fourth Michigan Infantry.

GENERAL DISCUSSION.

It will be seen that only one of the three regiments constituting this brigade, namely, the Thirty-fourth Michigan Infantry, imported

a case of typhoid fever into the Virginia camp. No case of this disease had occurred at the State encampment. As the regiments constituting this brigade left Camp Alger, Va., on June 23 and 24, sufficient time had not elapsed between their arrival and departure to allow the development of typhoid fever in their camps.

It has been impossible to obtain any data of value concerning the origin and course of typhoid fever amongst these regiments after their arrival in the island of Cuba.

A certain number of recruits for each of these regiments arrived at Camp Alger after their departure for Cuba. Typhoid fever appears to have developed amongst the recruits left behind from each regiment. As with the regiments of the First and Second Divisions, the disease began amongst these recruits during the latter part of July and decidedly increased during August while accompanying the Second Division on its march through Virginia.

Table showing for the regiments of the Second Army Corps assembled at Camp Alger, Va., the mortality and morbidity from typhoid fever.

Regiments.	Mean strength.	Cases of typhoid fever.		Deaths from typhoid fever.	Deaths from all diseases.
		Certain.	Certain and probable.		
FIRST DIVISION.					
65th New York	1,221	212	219	14	18
7th Ohio	1,169	123	125	4	5
1st New Jersey	1,275	35	58	8	10
8th Pennsylvania	1,044	91	101	8	9
12th Pennsylvania	837	107	123	23	24
13th Pennsylvania	824	97	105	15	19
3d Virginia	1,141	43	70	13	14
1st Connecticut	1,085	135	142	19	20
Total	8,596	843	943	104	119
SECOND DIVISION.					
22d Kansas	1,199	52	83	11	15
159th Indiana	1,190	80	89	8	11
3d New York	1,211	155	185	31	35
7th Illinois	1,219	72	119	2	2
6th Pennsylvania	1,236	35	36	6	9
4th Missouri	1,196	127	156	18	24
9th Ohio Battalion	384	39	54	5	5
3d Missouri	1,165	97	100	9	13
1st Rhode Island	1,209	217	269	10	11
2d Tennessee	1,202	90	192	8	15
Total	11,211	964	1,283	108	140
Total Second Army Corps	19,807	1,807	2,226	212	259
6th Illinois[1]			75	8	12
6th Massachusetts[1]			196	18	12
8th Ohio[1]			23	9	64
New York Cavalry, A and C[1]			12	1	2
9th Massachusetts[1]			109	34	85
33d Michigan[1]			41	14	33
34th Michigan[1]			44	26	48
Total[1]			2,726	322	515

[1] Sent to Cuba and Porto Rico after a short stay at Camp Alger.

Table showing for the regiments of the Second Army Corps assembled at Camp Alger, Va., the mortality and morbidity from typhoid fever—Continued.

Regiments.	Deaths from typhoid fever in 100 cases of—		Percentage of deaths from typhoid to deaths from all diseases.	Morbidity of typhoid fever in 1,000 mean strength.		Deaths from typhoid fever in 1,000 of mean strength.
	Certain typhoid.	Certain and probable.		For certain cases of typhoid.	For certain and probable cases of typhoid.	
FIRST DIVISION.						
65th New York	6.60	6.39	77.77	173.62	179.36	11.46
7th Ohio	3.25	3.20	80.00	105.21	106.93	3.42
1st New Jersey	22.85	13.79	80.00	27.44	45.49	6.27
8th Pennsylvania	8.79	7.92	88.88	87.16	96.74	7.66
12th Pennsylvania	21.49	18.69	95.83	115.91	146.95	27.47
13th Pennsylvania	15.46	14.28	78.94	117.83	127.42	18.20
3d Virginia	30.23	18.57	92.85	37.68	61.34	11.39
1st Connecticut	14.07	13.38	95.00	124.41	130.87	17.51
Total	12.33	11.02	87.39	98.06	109.70	12.09
SECOND DIVISION.						
22d Kansas	21.15	13.25	73.33	43.37	69.22	9.17
159th Indiana	10.00	8.98	72.72	67.22	74.78	6.72
3d New York	20.00	16.75	88.57	127.99	152.76	25.59
7th Illinois	2.77	1.68	100.00	59.06	97.62	1.66
6th Pennsylvania	17.14	16.66	66.66	28.31	29.12	4.83
4th Missouri	14.17	11.53	75.00	106.18	130.43	15.05
9th Ohio Battalion	12.82	9.25	100.00	101.56	140.62	13.02
3d Missouri	9.27	9.00	69.23	83.26	85.83	7.72
1st Rhode Island	4.60	3.71	90.91	179.48	222.49	8.27
2d Tennessee	8.88	4.16	53.33	74.85	159.65	6.65
Total	11.20	8.41	77.14	85.98	114.44	9.63
Total Second Army Corps	11.73	9.52	81.87	91.23	112.38	10.70

MALARIAL DISEASES IN THE SECOND ARMY CORPS, CAMP ALGER, VA.

A comparison of the individual histories of the several regiments constituting the Second Army Corps will show that in the large majority of these regiments the diagnosis of malarial disease, either as intermittent, remittent, or simply as malaria, has been given to most of the cases of fever admitted to sick report. Indeed, next to intestinal disorders, malarial cases have contributed the largest number to the sick list, the relative figures being 243.5 cases per 1,000 for intestinal disorders and 185.6 cases per 1,000 for malarial diseases.

As the region round about Camp Alger, Va., including the city of Washington and the district of country lying along the Potomac River, has been during certain years well known for the prevalence of malarial diseases, especially during the months of July, August, and September, it becomes necessary to look closely into the matter of the occurrence of malarial affections amongst the troops encamped at Camp Alger, Va., during the summer of 1898.

If the monthly regimental reports are examined attentively and the duration of the supposed malarial diseases accurately determined, it will be found that many of these supposed malarial affections lasted

less than twenty-four hours and that not less than 33 per cent were returned to duty at the expiration of two days.

Another important fact bearing upon the nature of these cases is that in June, when the occurrence of malarial diseases is extremely rare in the vicinity of Washington, this disease had already made considerable progress in the majority of regiments stationed at Camp Alger, Va., if the diagnosis of the regimental medical officers is to be accepted as correct.

Since, however, blood examinations were not made in order to substantiate the diagnosis of malarial diseases, we do not hesitate to state that, in our opinion, these mild fevers were not, as a rule, of malarial character. We believe that many of them, perhaps the majority, were due to intestinal disturbances brought on through indiscretion in diet and by the new conditions to which the young soldier was subjected.

Concerning the cases of supposed malarial diseases of longer duration we have already repeatedly pointed out, in the histories of individual regiments, the large number of cases which, upon transfer to division or general hospitals, have been changed in diagnosis to typhoid fever, and we have indicated our belief that many cases which did not last more than ten days, or which were furloughed prior to the time when a diagnosis could be made, were probable cases of that disease.

We will have occasion to point out hereafter that the men who were subject to these malarial attacks had acquired a considerable immunity to subsequent attacks of typhoid fever as compared with those men who did not experience such supposed malarial attacks.

For the purpose of more definitely clearing up the character of these cases this board requested of the Surgeon-General that a competent observer should be sent to Camp Alger, Va., for the purpose of making blood examinations of cases of fever at that encampment. In response to this request Acting Asst. Surg. James Carroll, U. S. Army, visited Camp Alger, Va., on August 24, 26, and 29. The subjoined table gives the results of the microscopic examination of the blood, together with the application of Widal's test:

To determine the general types of fever at Camp Alger, Va.

Observation.	Command.	History.	Examination for malarial parasites.	Widal.
1. Wm. A. G	Co. E, 12th Pennsylvania.	Chilly sensations followed by fever. Believed to be convalescing from mild attack of malarial fever. Admitted to sick report day after blood examination.	Negative.	Positive.
2. H. C. R	do	A number of frank chills, followed by fever and sweating. Believed to be convalescing from mild attack of malarial fever. Admitted to sick report day after blood examination.	do	Do.
3. H. W. S	do	Chilly sensations, followed by slight malaise. Not on sick report.	do	Negative.

To determine the general types of fever at Camp Alger, Va. –Continued.

Observation.	Command.	History.	Examination for malarial parasites.	Widal.
4. J. H	Co. E, 1st New Jersey.	Chilly sensations last night. Has had similar sensations regularly every night for 5 days, followed always by fever. Is taking quinine, gr. 2 q. 4 hours. Diagnosis: Malarial fever.	Negative	Negative.
5. J. C. R	Co. E, 7th Ohio	Sick about 1 week. No distinct chills, but cold and warm sensations. Cold in the morning and warm during rest of the day and at night. Taking quinine. Diagnosis: Malarial fever.	do	Partial reaction.
6. F. L	Co. E, 3d Missouri.	Sick 4 days in hospital. Has had diarrhea continuously. Temperature remittent for the last 2 days, and has now dropped to subnormal. No previous record of temperature. Taking quinine. Diagnosis: Malarial fever.	do	Positive.
7. Wm. D	Co. C, 13th Pennsylvania.	Several evenings frank chills, followed by fever and sweating. Temperature normal this a. m.; is now (11 a. m.) 103. Diagnosis: Malarial fever.	do	Partial reaction.
8. J. A	Hospital corps	Is semidelirious, with subsultus, etc. Roseola. Diagnosis: Typhoid fever.		Positive.
9. E. W	Co. I, 3d New York.	In third week. Roseola. Diagnosis: Typhoid fever.		Do.
10. J. S	Co. B, 12th Pennsylvania.	do		Do.
11. F. J. H	Co. B, 1st New Jersey.	Early stage. In hospital 3 days. Roseola. Diagnosis: Typhoid fever.		Do.
12. S. J	Co. G, 3d Virginia.	Convalescent. Diagnosis: Typhoid fever.		Do.
13. J. F. C	Co. B, 65th New York.	do		Do.
14. W. C. W	Co. E, 3d Virginia.	Convalescent. Fourth week. Diagnosis: Typhoid fever.		Do.
15. F. H. S	Co. B, 7th Ohio	Severe case. Diagnosis: Typhoid fever.		Do.
16. W. W	do	do		Do.
17. Wm. W	Band, 65th New York.	Between third and fourth weeks. Temperature has reached normal. Diagnosis: Typhoid fever.		Do.
18. W. F. F	Hospital corps	This man has been nursing cases of typhoid fever. He is just taken sick. Temperature, 101. Has coated tongue, with bright red tip and margin. Malaise.	Negative	Negative.
19. J. K	Co. A, 1st New Jersey.	Sick 5 days. Has had repeated chilly sensations and fever. Temperature, 99.2 this morning and is rising now. Diagnosis: Remittent fever.	do	Positive.
20. C. K	Co. C, 13th Pennsylvania.	Chilly sensations and fever, with sweating, about 2 weeks ago. Has also suffered from insomnia and restlessness. On sick report 1 week. Regarded as a doubtful case. Has typical typhoid tongue. One rose spot on abdomen. Diagnosis on admission: Ephemeral fever.	do	Do.
21. S. E. H	Co. A, 7th Ohio	Cold sensations, followed by fever and sweating; chills repeated several times a day for several days. Has been sick 10 days. Has a little temperature now—was 101.2 this morning. Diagnosis: Malaria.	do	Do.
22. J. R	Co. G, 7th Ohio	Has been sick 2 weeks. Began with fever. Never had a chill. His tongue is coated and the edges are bright red. Diagnosis: Malarial intermittent.	do	Do.

To determine the general types of fever at Camp Alger, Va.—Continued.

Observation.	Command.	History.	Examination for malarial parasites.	Widal.
23. M. McD	Co. I, 1st New Jersey.	Sick about 1 week. Temperature normal; is convalescent. Diagnosis: Remittent fever.	Negative.	Motility impaired, and there is a slight agglutination. Control used.
24. C. B	Co. A, 7th Ohio	Says he had a typical shake 4 days ago, followed by fever and sweating. Had a light chill on the following evening, but none since. Has been sick in all about 8 days, and is convalescing. Does not look badly, but says he feels very weak. Dr. Palmer reports that he found crescents and ring forms in this man's blood 2 days ago.	do	Negative.

The result of the blood examination in the foregoing cases, selected at random, points plainly to the typhoid character of the majority of those cases considered to be of malarial origin.

We have also traced the cases of supposed remittent and intermittent fever which were transferred from the division hospitals at Camp Alger, Va., to the general hospital at Fort Myer, Va. Through the courtesy of Acting Asst. Surg. J. J. Curry, pathologist of the latter hospital, to whom this board is much indebted for valuable assistance, we have been able to follow 92 cases of supposed remittent fever admitted from 20 regimental organizations of the Second Army Corps.

In 31 cases the disease was found to be of an entirely different nature, the diagnosis being changed to rheumatism, febricula, debility, heat prostration, pleurisy, pneumonia, acute bronchitis, acute diarrhea and acute conjunctivitis.

Of the remaining 61 cases of supposed remittent fever, the diagnosis was changed in one case to tertian intermittent fever and in 60, or 98.3 per cent, to typhoid fever.

We are further informed by Dr. Curry that during his service at the general hospital at Fort Myer, Va., where he was daily conducting blood examinations from June until September, he did not find the malarial parasite in any other case of supposed malarial disease transferred from Camp Alger.

If further testimony were needed to show that malarial diseases were extremely rare among the troops of the Second Army Corps stationed at Camp Alger, Va., we would point to the First Connecticut Infantry, which left that camp on September 7, 1898, and shortly thereafter transferred to hospitals at Hartford and New Britain, Conn., 101 cases of fever. Of these, we have been informed by the

medical superintendents of the hospitals in the above-mentioned cities, that 98 received the diagnosis of typhoid fever and only three the diagnosis of malaria. We have been further informed that in the latter cases the diagnosis of malaria was based solely on the temperature curve, and not upon blood examinations.

As this regiment left Camp Alger, Va., at a time when malarial diseases should have been particularly rife, and as its regimental camp site and the conditions under which its men were placed were not exceptional, the irrefutable evidence above given as to the character of its fevers will show that notwithstanding the opinions of the regimental medical officers, malarial fever did not exist, save to an unimportant extent, at Camp Alger, Va.

We have already expressed our belief that many of these short fevers were due to errors in diet and to the changed conditions surrounding the young soldier. We have also entertained the opinion that some of these fevers of shorter duration might be due to infection with the typhoid bacillus, and hence were to be considered as cases of mild or abortive typhoid fever.

The coincident rise and fall of these fevers with that of the occurrence of recognized typhoid fever in certain companies and regiments has led us to look more carefully into this subject. For this purpose we have with much labor followed all cases of fever, of whatever character, occurring in 19 regiments between June 1 and December 31, 1898, in order to ascertain how many of these men afterwards contracted typhoid fever.

We have also carefully followed for the same period all soldiers in these regiments who did not have these supposed malarial attacks, with the object of finding out whether these men were more or less susceptible to attacks of typhoid fever.

In conducting this investigation we have followed by name, company, and regiment every soldier in these 19 regiments of the Second Army Corps who was admitted to sick report with any form of febrile disturbance, no matter what diagnosis was given to the latter, and have only excluded those in which the febrile condition was afterwards plainly shown to be a part of the typhoid attack. All other cases have been reckoned under the head of "Preceding malarial diseases," since this was the diagnosis largely given to these cases. We have included, of course, supposed malarial attacks occurring during the month of June, when typhoid fever did not prevail. Had we excluded these cases, which we might have properly done, and only included those shorter fevers which prevailed during the epidemic of typhoid fever, namely, during July, August, and September, the percentage of these cases which were afterwards followed by typhoid fever would have been still less.

The results obtained from this investigation are embodied in the following table:

Cases of typhoid fever among men with or without preceding malarial disease.

Regiments.	Mean strength.	Cases of malaria.	Typhoid fever with preceding malaria.		Men not having had malaria.	Typhoid fever without preceding malaria.		Total cases of typhoid fever.
			Number of cases.	In 100 malarial cases.		Number of cases.	In 100 individuals without malaria.	
3d Missouri	1,168	211	7	3.3	957	91	9.5	98
4th Missouri	1,192	236	3	1.2	956	119	12.4	122
7th Ohio	1,272	210	1	.4	1,062	100	9.4	101
7th Illinois	1,203	174	1	.5	1,029	50	3.8	51
1st Connecticut	1,303	149	12	8.0	1,154	127	11.0	139
22d Kansas	1,215	300	1	.3	915	51	5.5	52
1st New Jersey	1,343	106			1,237	35	2.8	35
6th Pennsylvania	1,234	56	1	1.7	1,178	34	2.8	35
159th Indiana	1,194	303	1	.3	891	80	8.9	81
8th Pennsylvania	1,049	201	2	.9	848	89	10.4	91
12th Pennsylvania	823	164	3	1.8	659	104	15.7	107
3d Virginia	1,123	109			1,014	39	3.8	39
2d Tennessee	1,096	175	3	1.7	921	85	9.2	88
13th Pennsylvania	795	179			616	97	15.7	97
1st Rhode Island	1,085	538	10	1.8	547	211	38.5	221
65th New York	1,218	153	5	3.2	1,065	157	14.7	162
6th Illinois	1,213	289	5	1.7	924	72	7.7	77
6th Massachusetts	1,201	294	7	2.3	907	193	21.2	200
3d New York	1,261	236	1	.4	1,025	154	15.0	155
Total	21,988	4,083	63	1.5	17,905	1,888	10.5	1,951

An examination of this table will show that in a mean strength of 21,988 men there were 4,083 who experienced attacks of fever, which was generally designated as some form of malarial disease, most frequently as remittent malarial fever. Of this number only 63, or 1.5 per cent, suffered from subsequent attacks of typhoid fever. On the other hand, of 17,905 men who did not experience any attack of supposed malarial fever, 1,888, or 10.5 per cent, contracted typhoid fever. In other words, those soldiers who had fevers of short duration and which were generally designated as malarial fever were seven times less liable to subsequent attacks of typhoid fever than those who had not suffered with these milder fevers.

To put the subject in another way, of 1,951 men who had recognized typhoid fever, 63, or 3.2 per cent, had preceding attacks of supposed malarial fever, while 1,888, or 96.7 per cent, had no such preceding attacks.

We thus see that these fevers of milder form, occurring during the time when typhoid fever was epidemic in the regiments at Camp Alger, Va., conferred a remarkable immunity against subsequent attacks of typhoid fever. This was not found to be the case in only a few selected regiments, but in all regiments studied in the Second Army Corps. Similar results, even more striking, have been obtained from a careful study of the regiments of other army corps.

Bearing upon this point, we submit herewith a diagram showing the curve of recognized cases of typhoid fever in these 19 regiments

of the Second Army Corps and in 7 regiments of the Third Division, Seventh Corps, for the period May 30 to November 30, 1898, together with a curve for supposed malarial diseases during the same period.

It will be seen that there is a remarkable similarity between the rise and fall of these two diseases, and what is particularly striking is the marked fall in supposed malarial diseases during the month of September, which is contrary to what would have occurred in the vicinity of Washington during the latter month. Observations extending over twenty-six years, made by one of the members of this board, have demonstrated that the month of September gives the highest rate for malarial fevers in and near the city of Washington, D. C.

Typhoid and malarial fever at Camp Alger, Va., and Jacksonville, Fla.

EIGHTEEN ALGER REGIMENTS.

Months.	Mean strength.	Typhoid fevers.		Malarial fevers.	
		Number of cases.	In 1,000 of mean strength.	Number of cases.	In 1,000 of mean strength.
May	16,051	7	0.43	117	7.16
June	19,364	31	1.60	415	21.42
July	21,356	324	15.17	549	25.70
August	21,392	874	40.84	1,147	53.61
September	20,785	593	28.53	865	41.61
October	19,896	262	13.16	302	15.17
November	15,330	55	3.59	145	9.45

SEVEN JACKSONVILLE REGIMENTS.

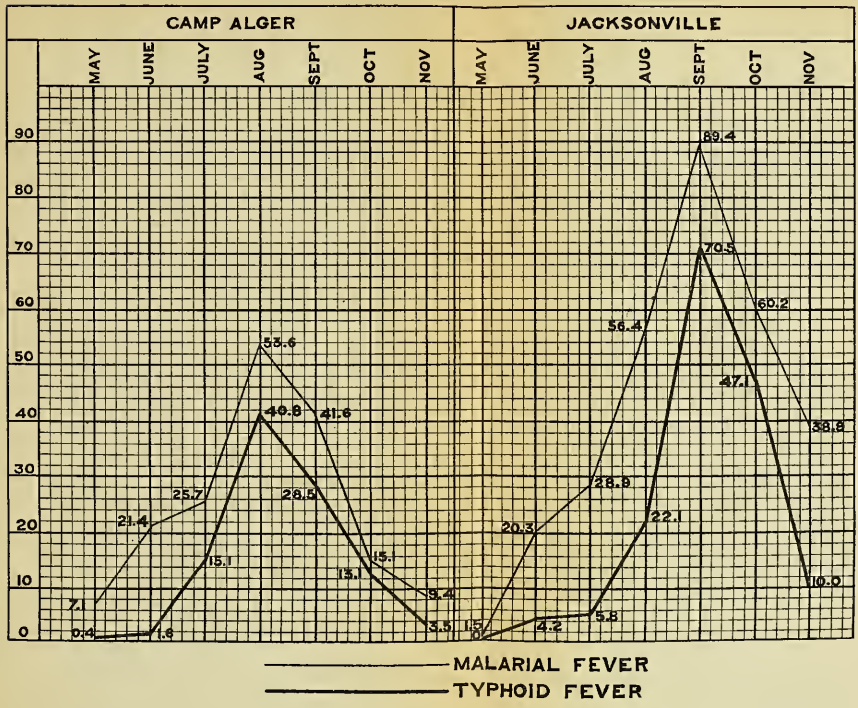
May	3,699			5	1.35
June	3,974	17	4.27	81	20.38
July	8,426	49	5.81	244	28.95
August	8,505	188	22.10	480	56.43
September	8,175	577	70.59	731	89.41
October	7,736	365	47.18	466	60.23
November	6,936	70	10.09	270	38.92

It was later a matter of considerable regret to this board that the opportunity had not been utilized to submit samples of blood from these so-called malarial fevers to the Widal test. Frankly speaking, this was not done at the time of our inspection of Camp Alger, Va., because we were not prepared to regard these shorter fevers as mild infections due to the typhoid bacillus. This opinion was only arrived at after the opportunity for making use of this material had passed.

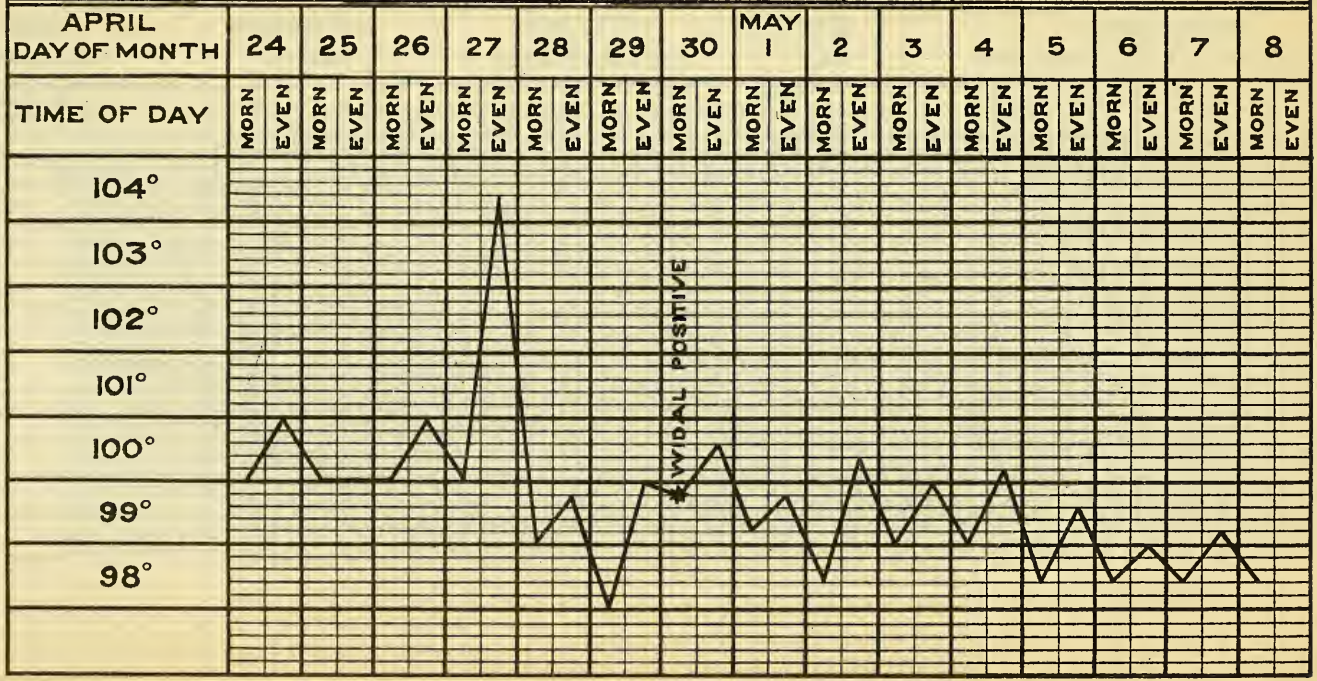
Fortunately, one of the members of this board was ordered to Cuba for the purpose of studying an outbreak of typhoid fever in the camp of the Eighth U. S. Cavalry, near the city of Puerto Principe. At this camp, in addition to well-marked cases of typhoid fever of average severity, there were seen in the department hospital cases of much milder type and which for this reason were designated by the surgeon in attendance as remittent malarial fever.

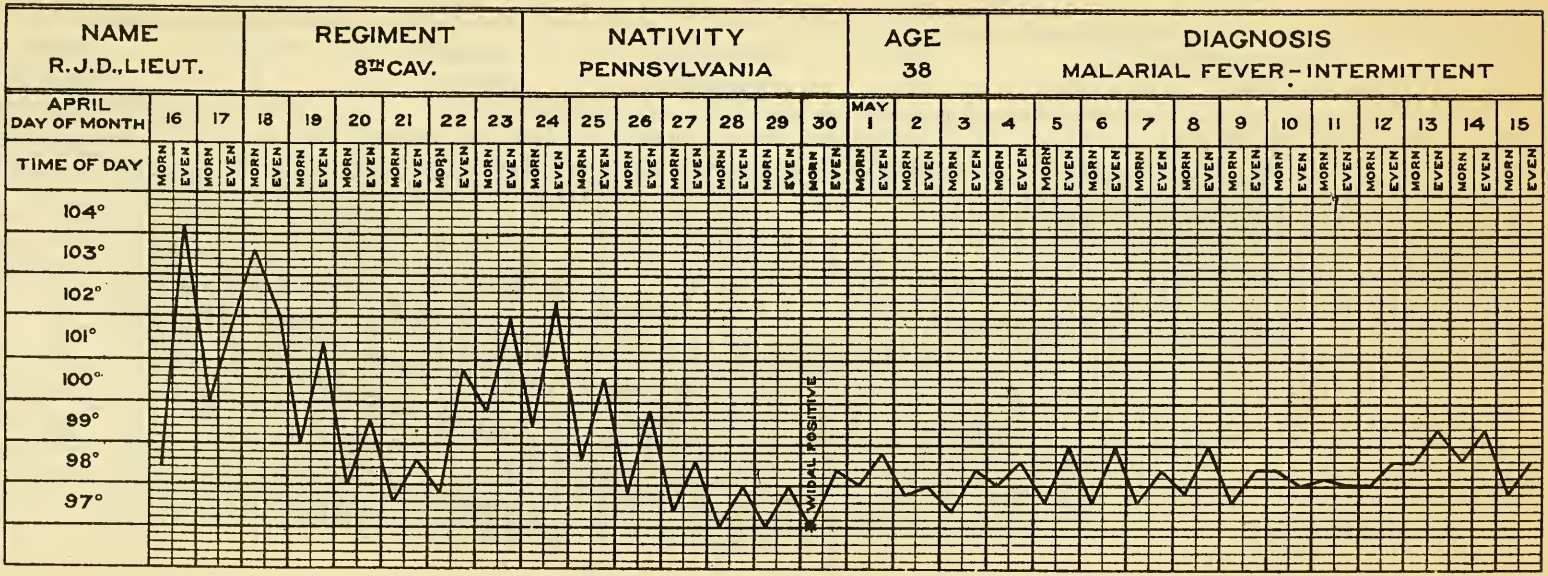
With the object of ascertaining the character of these milder fevers, samples of blood were taken from all fever cases in the wards of the department hospital and afterwards subjected to the Widal test.

DIAGRAM SHOWING, FOR CAMP ALGER AND JACKSONVILLE, THE PROPORTION OF CASES OF TYPHOID AND MALARIAL FEVERS IN 1000 OF MEAN STRENGTH

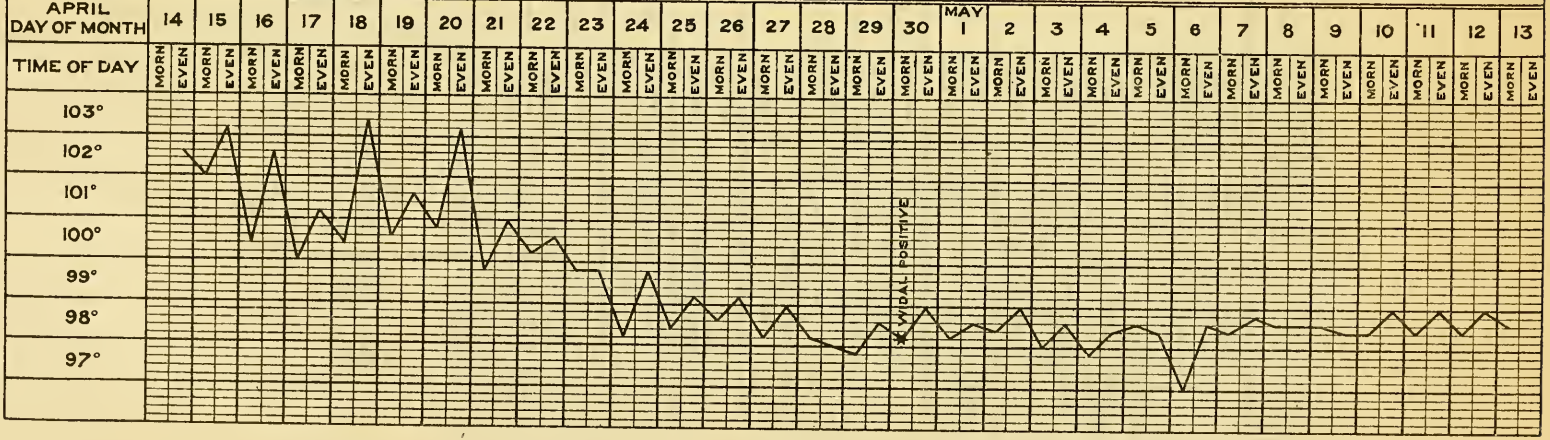


NAME	COMPANY	REGIMENT	NATIVITY	AGE	DIAGNOSIS
J.B.K.	M	15TH INFT.	MISSOURI	21	MALARIAL FEVER REMITTENT

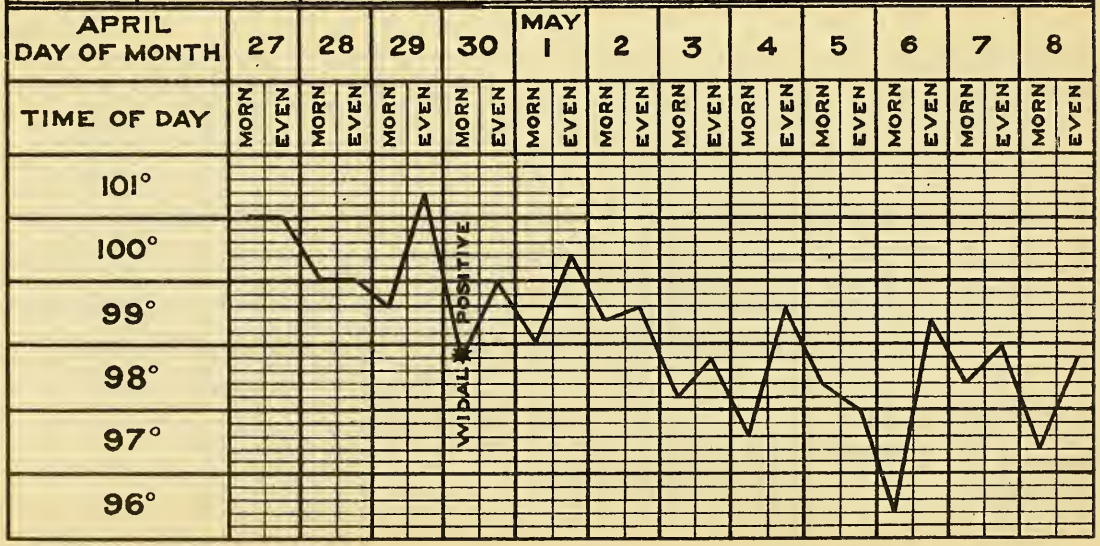


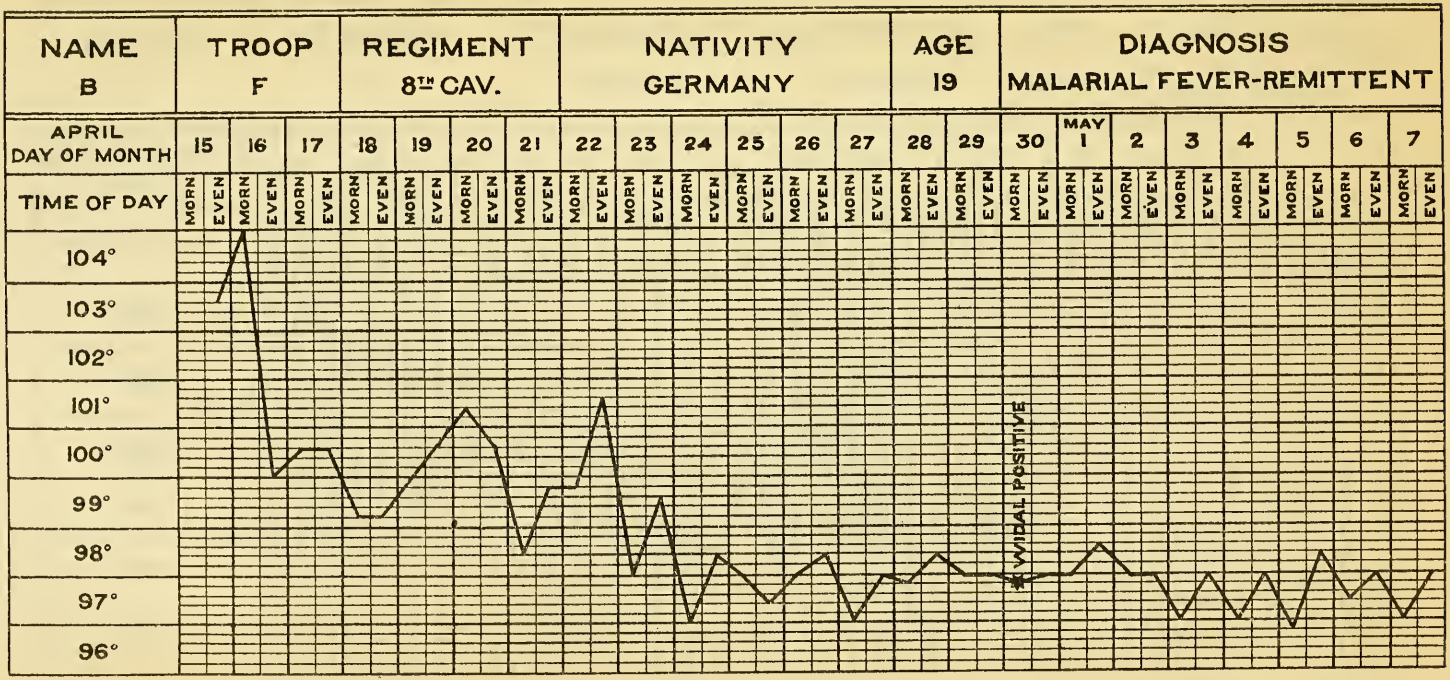

NAME
R.J.D., LIEUT.
REGIMENT
8TH CAV.
NATIVITY
PENNSYLVANIA
AGE
38
DIAGNOSIS
MALARIAL FEVER - INTERMITTENT
APRIL
DAY OF MONTH
16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
MAY
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
TIME OF DAY
MORN EVEN
104°
103°
102°
101°
100°
99°
98°
97°
WIDAL POSITIVE

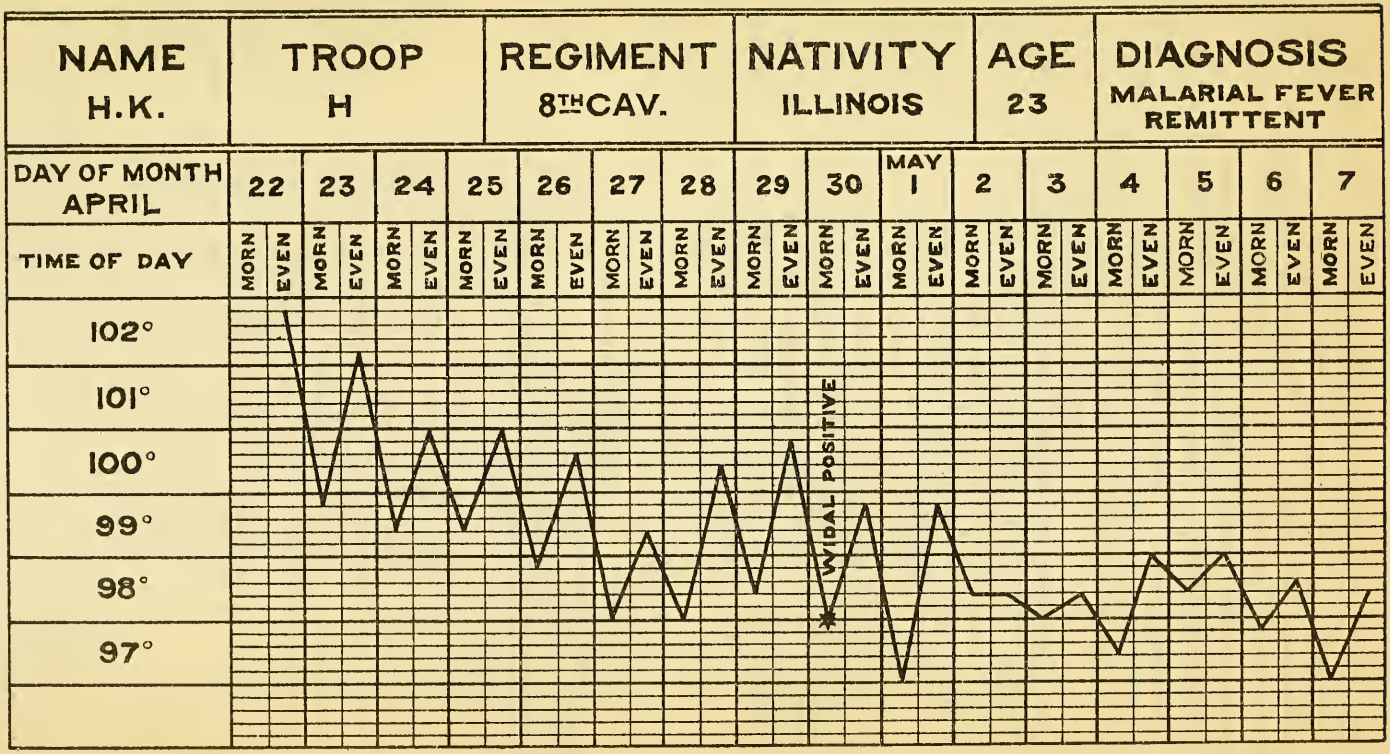
NAME C.H.,SGT.	TROOP E	REGIMENT 8TH CAV.	NATIVITY GERMANY	AGE 31	DIAGNOSIS MALARIAL FEVER - REMITTENT



NAME	TROOP	REGIMENT	NATIVITY	AGE	DIAGNOSIS
C.P.A.	E	8TH CAV.	ILLINOIS	22	MALARIAL FEVER REMITTENT




NAME
B
TROOP
F
REGIMENT
8TH CAV.
NATIVITY
GERMANY
AGE
19
DIAGNOSIS
MALARIAL FEVER-REMITTENT
APRIL
DAY OF MONTH
15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
MAY
1 2 3 4 5 6 7
TIME OF DAY
MORN EVEN
104°
103°
102°
101°
100°
99°
98°
97°
96°
* WIDAL POSITIVE


NAME
H.K.
TROOP
H
REGIMENT
8TH CAV.
NATIVITY
ILLINOIS
AGE
23
DIAGNOSIS
MALARIAL FEVER
REMITTENT
DAY OF MONTH
APRIL
22
23
24
25
26
27
28
29
30
MAY
1
2
3
4
5
6
7
TIME OF DAY
MORN
EVEN
102°
101°
100°
99°
98°
97°
WIDAL POSITIVE

Thirteen of these cases were diagnosed as typhoid fever and 16 as malarial fever remittent. The result of the test was as follows:

Of the cases diagnosed as typhoid fever, a positive reaction was obtained in 10, an incomplete reaction in 2, and a negative reaction in 1 case. Of the cases diagnosed as malarial fever remittent, a positive reaction was obtained in 12 and a negative reaction in 4 cases.

Through the kindness of Major Armstrong, brigade surgeon, U. S. Army, chief surgeon of the department, we are able to present herewith a few charts of these supposed malarial fevers of short duration in which the Widal reaction was positive.

Since typhoid fever is frequently manifested by symptoms of intestinal disturbance as well as fever, and since these two symptoms may be relatively more or less prominent in different cases, we have thought that perhaps many cases of this disease in more resistant individuals would occur as simple diarrheas without attracting particular attention.

We have therefore made a like effort to ascertain what percentage of those soldiers having intestinal disturbances subsequently contracted typhoid fever as compared with those who had not suffered from intestinal disturbances. Here, too, we have excluded those intestinal attacks which were a part of the typhoid attack. The subjoined table will indicate the results obtained.

Cases of typhoid fever among men with or without preceding diarrheal attacks.

Regiments.	Mean strength.	Cases of diarrheal disease.		Typhoid fever with preceding diarrhea.		Men not having had diarrhea.	Typhoid fever without preceding diarrhea.		Total cases of typhoid fever.
		Number of cases.	In individuals.	Number of cases.	In 100 individuals with diarrhea.		Number of cases.	In 100 individuals without diarrhea.	
3d Missouri	1,168	364	331	16	4.8	837	82	9.7	98
4th Missouri	1,192	185	176	2	1.1	1,016	120	11.8	122
7th Ohio	1,272	100	96	4	4.1	1,176	97	8.2	101
7th Illinois	1,203	289	247	11	4.4	956	40	4.1	51
1st Connecticut	1,303	639	468	32	6.8	835	107	12.8	139
22d Kansas	1,215	247	228	3	1.3	987	49	4.9	52
1st New Jersey	1,343	164	151	3	1.9	1,192	32	2.6	35
6th Pennsylvania	1,234	76	69	------	------	1,165	35	3.0	35
159th Indiana	1,194	180	170	8	4.7	1,024	73	7.1	81
8th Pennsylvania	1,049	57	57	------	------	992	91	9.1	91
12th Pennsylvania	823	42	41	1	2.4	782	106	13.5	107
3d Virginia	1,123	231	198	5	2.5	925	34	3.6	39
2d Tennessee	1,096	70	70	4	5.7	1,026	84	8.1	88
13th Pennsylvania	795	281	221	20	9.0	574	77	13.4	97
1st Rhode Island	1,085	149	137	7	5.1	948	214	22.5	221
65th New York	1,218	97	94	4	4.2	1,124	158	14.0	162
6th Illinois	1,213	120	108	1	.9	1,105	76	6.8	77
6th Massachusetts	1,301	1,746	772	35	4.5	429	165	38.4	200
3d New York	1,261	317	269	18	6.9	1,001	137	13.6	155
Total	21,988	5,354	3,894	174	4.4	18,094	1,777	9.8	1,951

This table will show that of 3,894 individuals who suffered with some form of diarrheal disturbance only 174, or 4.4 per cent, subsequently contracted typhoid fever; whereas of 18,094 men who had no intestinal disorder not less than 1,777, or 9.8 per cent, fell victims to typhoid fever.

In other words, those soldiers who were free from attacks of diar-

rhea were more than twice as liable to contract typhoid fever. Indeed, if we deduct those cases of typhoid fever in which the attack of diarrhea occurred during the month of June, at a time when typhoid had scarcely begun, and which diarrheas could not, therefore, have been protective, we find that the percentage of those subsequently contracting typhoid fever falls still lower. In order to determine this point we herewith submit a table relating to four regiments of the Second Army Corps, taken at random, in which cases of typhoid fever preceded by diarrheas occurring during the month of June have been excluded:

Cases of typhoid fever among the men of four regiments of the Second Army Corps, taken at random, with or without preceding diarrheal attacks. June diarrheas excluded.

Regiments.	Mean strength.	Cases of diarrheal disease.		Typhoid fever with preceding diarrhea.		Men not having had diarrhea.	Typhoid fever without preceding diarrhea.		Total cases of typhoid fever.
		Number of cases.	In individuals.	Number of cases.	In 100 individuals with diarrhea.		Number of cases.	In 100 individuals without diarrhea.	
3d Missouri	1,168	364	331	2	0.3	837	82	9.7	84
7th Illinois	1,203	289	247	2	.2	956	40	4.1	42
13th Pennsylvania	795	281	221	6	2.7	574	77	13.4	83
3d New York	1,261	317	260	4	1.5	1,001	137	13.6	141
Total	4,437	1,251	1,059	14	1.3	3,368	336	9.9	350

An examination of the foregoing table will show that the men who suffered from diarrheal attacks during those months when typhoid fever was prevailing at Camp Alger, Va., were seven times less liable to contract typhoid fever than those who had no diarrhea.

Taking the total number of recognized cases of typhoid fever in these nineteen regiments, viz, 1,951, we find that 174, or 8.9 per cent, were preceded by diarrhea, while 1,777, or 91.9 per cent, had no previous diarrheal disturbance.

We therefore conclude that many of these supposed diarrheas were really manifestations of infection by the typhoid bacillus, since we can not otherwise account for the protective influence here so strikingly manifested.

We believe that the facts which we have here gathered point irresistibly to the conclusion that at Camp Alger, Va., in addition to the occurrence of a large number of recognized cases of typhoid fever of average duration and severity, there were a still larger number of milder infections appearing as simple diarrheas or as fevers of short duration. We shall have occasion to draw the same conclusion from our study of typhoid fever in the other army corps.

ORIGIN AND SPREAD OF TYPHOID FEVER AT CAMP ALGER, VA.

There was nothing in the general topography of Camp Alger, Va., that should have made it an unhealthy camp site. Its general eleva-

tion above the Potomac River was about 300 feet, while the surface was rolling and well drained.

The lack of a good natural water supply should have prevented the rapid concentration of a large number of regiments at this point. We have already seen that one source of discomfort in the early history of the camp was the lack of sufficient water, and that to this was added, in the case of some of the regiments, overcrowding of the camp site. Notwithstanding this, typhoid fever furnished only 1.42 cases per 1,000 men during the first forty days of the encampment.

We have already pointed out that typhoid fever was imported into this camp by a number of the regimental organizations, and that sources for additional individual infections could be found in the city of Washington and surrounding country. The origin of the disease is therefore plain.

As to the matter of the further propagation of this disease, until it had assumed epidemic form there did not appear to be any doubt on the part of the various medical officers on duty at Camp Alger at the time of our inspection but that the water supply was at fault. The condemnation of the latter and of the shacks at which food and drinks of different kinds were sold was unanimous.

Although no positive evidence showing undoubted water contamination was presented, we were, nevertheless, impressed with the possibility of this pollution of the supply, and hence in our letter of recommendation addressed to the adjutant-general of the First Division on August 24, 1898, we emphasized the necessity for the detail of two men in each company who should look after the sterilization of the water by boiling, and its careful storage in barrels.

Our subsequent careful study of the occurrence of typhoid fever by company organizations has convinced us that the spread of the disease by contamination of the water supply can not be sustained, except in the case of Company G, Twelfth Pennsylvania Infantry. This local company epidemic has been carefully commented on in the history of the Twelfth Pennsylvania Infantry.

We must look, therefore, to other modes of propagation than that of the water supply.

Upon the completion of our inspection at this camp we were impressed with the possibility of the spread of typhoid fever by tent infection, although at the time we had not obtained any positive data bearing on this particular mode of propagation of the disease. It was because of this belief that we made the following recommendation:

> We earnestly hope that the flooring of the tents, which has already been ordered, will be speedily put in position. It is certainly unwise to allow soldiers to sleep in the dirt and dust of their tents (as they are doing now, for instance, in the Sixty-fifth New York Infantry). Filth, possibly some of it infected with specific germs, may be and undoubtedly is brought from the most diverse sources into these tents on the feet of the men, tramped in the dust in which they sleep, and particles of it taken into their naso-pharynx. The board thinks it possible that the epidemic in Company E, Sixty-fifth New York Infantry, was spread in that way.

Since the above recommendation was made we have, in the course of our investigation, obtained much valuable evidence bearing on this mode of infection. This will be presented under the study of typhoid fever at Camp Meade, Pa. We would therefore include tent infection as one of the agencies concerned in the spread of typhoid fever at Camp Alger, Va.

We especially recommended the most careful supervision of the company sinks, and that each soldier be required to cover his excrement with dry earth as soon as deposited. This was intended to avoid, as far as possible, the contamination of food and drink by means of flies, and also for the purpose of minimizing the possibility of contamination of the soldier's person at the company sinks. We are of the opinion that typhoid fever was spread in this camp in both of these ways.

We would also include as a factor in the spread of this disease the undoubted pollution of the soil with the urine of those suffering with typhoid fever. Cases of this disease under the diagnosis of malarial fever of one kind or another were repeatedly treated by the regimental surgeon throughout the entire sickness. Patients still convalescing were also returned to their respective companies.

Since the investigations of Richardson, Horton Smith, and others have shown that the urine of the sick and convalescents from this disease frequently (20 to 25 per cent) contains typhoid bacilli in large numbers, there must have been abundant opportunity for the contamination of the soil with the specific germ.

Finally, we do not doubt that the disease was conveyed from the sick to the well in the division hospitals, and that the utterly inadequate methods of disinfection of stools, of the surface of the patient's body, and of the infected bedding and clothing, contributed to this mode of propagation.

CHAPTER VIII.

TYPHOID FEVER IN THE SECOND ARMY CORPS, CAMP MEADE, PA.

Commands.—First Maryland Infantry, Thirty-fifth Michigan Infantry, Tenth Ohio Infantry, Third Connecticut Infantry, Two hundred and second New York Infantry, Fifteenth Minnesota Infantry, Second Pennsylvania Infantry. Fourth New York Infantry, Two hundred and third New York Infantry, Second West Virginia Infantry, Fifth Massachusetts Infantry, Two hundred and first New York Infantry, First Delaware Infantry, Seventh Ohio Infantry. Eighth Pennsylvania Infantry, Twelfth Pennsylvania Infantry, Thirteenth Pennsylvania Infantry, First Rhode Island Infantry, Second Tennessee Infantry.

General remarks.—This camp site was chosen as favorable ground for a second encampment of the regiments of the Second Army Corps,

which had already suffered to such an extent from typhoid fever at Camp Alger, Va. It is situated a few miles west of Middletown, Pa., and on the north bank of the Susquehanna River.

Topography.—A detailed topographical map of the camp site could not be obtained. The general elevation of the regimental camp sites above the river was about 50 to 80 feet. This site was well suited for the encampment of troops, being elevated, rolling, and exceptionally well drained. At the time of our inspection only one battalion of the Thirty-fifth Michigan Infantry was found to occupy a camp site which was rather low and not well drained. Upon the recommendation of the board this battalion was moved to higher ground. The space allotted for regiments was ample.

Water supply.—Prior to the arrival of the troops at this camp several deep wells had been bored, from which an abundance of good water was obtained. This was pumped into tanks of sufficient capacity and from these distributed through iron pipes, under constant pressure, to the various regimental camps. During the first weeks of the encampment, prior to the laying of water mains, water was hauled to the regiments by water wagons and stored in barrels, but this crude method of water distribution was soon replaced by the means above described. These deep wells were so situated, as regards regimental encampments, as to be entirely free from any danger of contamination from surface drainage. The supply of water, therefore, in this encampment was abundant and of good quality.

Disposition of garbage and excreta.—Garbage was deposited in open pits and frequently covered with earth, or in a few instances, such as in the Second Tennessee and Two hundred and second New York Infantry, crematories were erected for the destruction of solid garbage. Excreta were deposited also in open pits. By order of the corps commander these pits for garbage and excreta were placed on the opposite side of the regimental camps from that chosen for the location of kitchens and mess tents, and in every instance the former were removed to a considerable distance from the company tents.

With regard to the sanitary condition of kitchen and company sinks, the following is extracted from the letter of the board addressed to the adjutant-general of the Second Army Corps October 8, 1898, upon the completion of our inspection of Camp Meade:

> The stringent orders of the commanding general concerning the care of sinks, as to individual and immediate covering of excreta, under the constant supervision of sentinels, has led to the very good sanitary condition of the sinks of the command; exceptionally was any fecal matter found uncovered. In no command inspected by the board during the past six weeks has an equally good sanitary condition of the sinks been found.

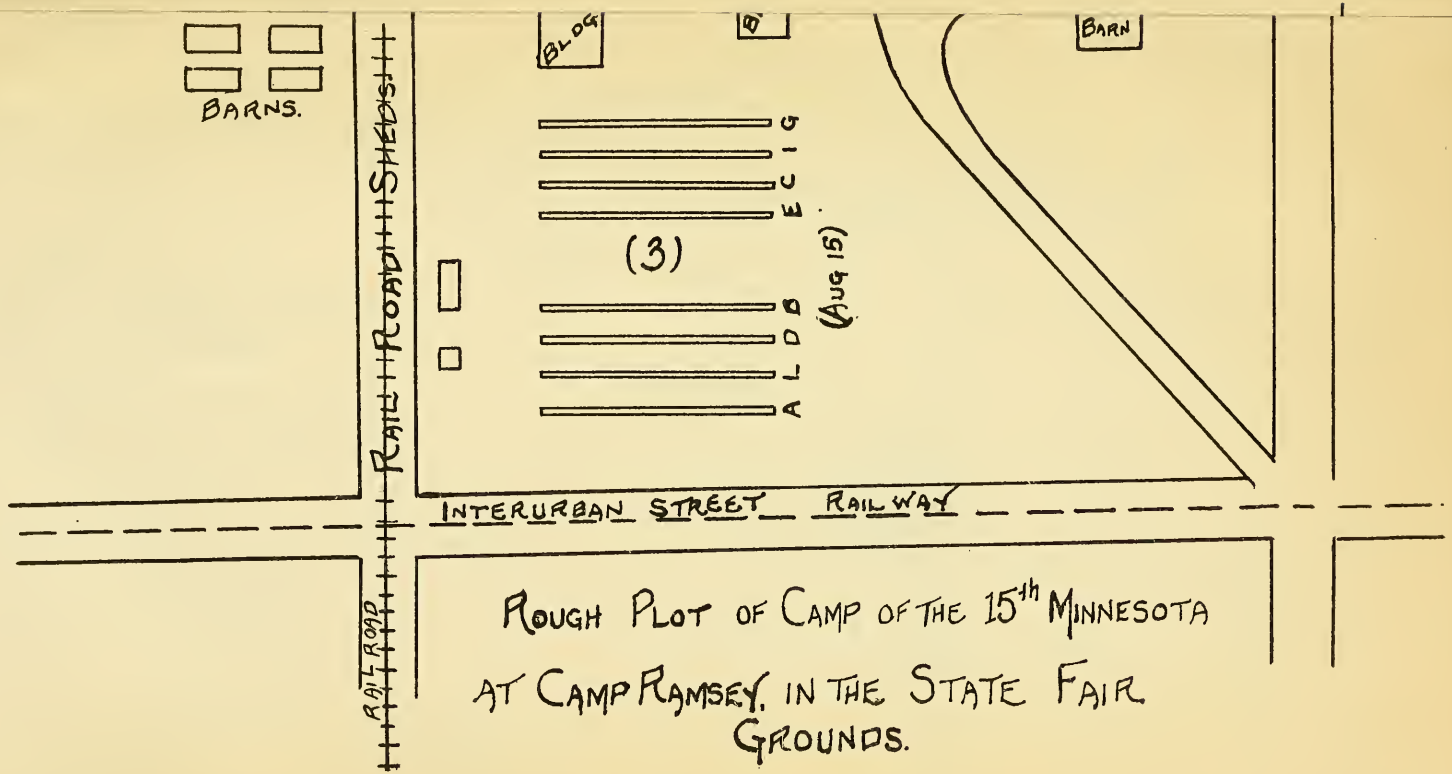
The general police of the regimental camps was excellent.

Tentage.—This was ample and, in addition, all tents were floored.

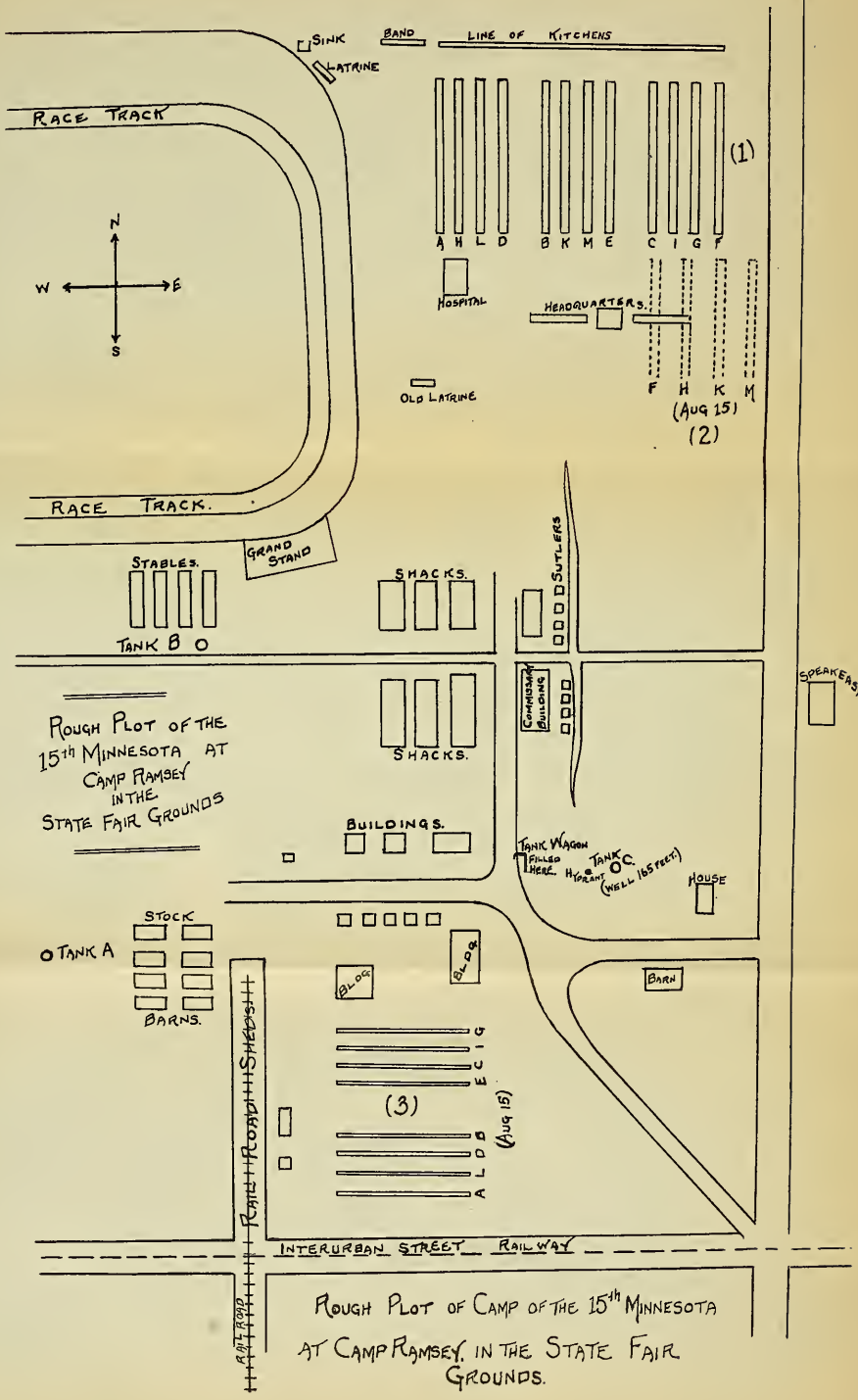
CONSIDERATION BY THE BOARD OF TYPHOID FEVER IN THE FIFTEENTH MINNESOTA INFANTRY.

Brief outline of the medical history.—Responding to the second call for volunteers, the Fifteenth Minnesota Infantry assembled at Camp Ramsey, the State camp, in the fair grounds near St. Paul, Minn., the first companies arriving there on the 5th of July, 1898. The regiment went into camp to the east of the race track (see I, general sketch map of Camp Ramsey), on ground which had been previously occupied by the Twelfth Minnesota, a first-call regiment, which had assembled here the latter part of April and departed for the national camp at Chickamauga about the 16th of May. The Fifteenth Minnesota remained on this camp site until the 15th of August, when, in consequence of a sharp outbreak of typhoid fever among four companies, the eight apparently unaffected companies were removed to much higher ground (see No. III on the above-mentioned map), while the four affected companies were shifted to new ground (see No. II on map) very near the first site. The respective companies remained thus encamped upon their new sites until the 23d of August, when, because of the development of the epidemic among the eight companies originally unaffected, encamped at site No. III on the map, and of the continued spread of the disease among the four first affected companies on site No. II on the map, the regiment marched about 6 miles to the Government reservation at Fort Snelling and went into camp there.

Here, also, as a precaution, the four first affected companies were at first kept widely apart from the other companies, but it was soon found that these other companies were now suffering quite as much, if not indeed more, than the first four, and at the end of a week after moving to Fort Snelling the latter joined the camp of the eight companies. Attention should be called to the fact that when the regiment moved to Fort Snelling, Company G, at that time the only company apparently unaffected, was left behind at Camp Ramsey for a day in order to police the abandoned camp sites. The regiment now remained encamped without further change at Fort Snelling until the 15th of September, when it departed by rail for the national camp in Pennsylvania. After having been already quite extensively ravaged by an epidemic of typhoid fever which had developed in its State camp, the Fifteenth Minnesota arrived at Camp Meade, the National camp in Pennsylvania, on the 18th of September, was assigned to the Third Brigade, First Division, of the Second Army Corps, and went into camp on high, rolling, well-drained ground. The other regiments of this brigade were the Eighth, Twelfth, and Thirteenth Pennsylvania, all from Camp Alger, Va., the Twelfth being temporarily attached under orders to be mustered out. (See histories of these regiments under Camp Alger.) The Fifteenth Minnesota remained in Camp Meade without change until the 16th of November, when it took train for Camp Mackenzie, near Augusta, Ga., arriving at the latter camp on the 18th. The regiment was still in this camp on December 31, 1898, and it was there when mustered out of service of the United States on March 27, 1899.



ROUGH PLOT OF CAMP OF THE 15th MINNESOTA AT CAMP RAMSEY. IN THE STATE FAIR GROUNDS.


PASTURE
SINK
LATRINE
BAND
LINE OF KITCHENS
RACE TRACK
(1)
A H L D
B K M E
C I G F
N
W
E
S
HOSPITAL
HEADQUARTERS.
F H K M
(AUG 15)
(2)
OLD LATRINE
RACE TRACK.
GRAND STAND
STABLES.
TANK B
SHACKS.
SUTLERS
SPEAKEASY
ROUGH PLOT OF THE 15th MINNESOTA AT CAMP RAMSEY IN THE STATE FAIR GROUNDS
SHACKS.
COMMISSARY BUILDING
BUILDINGS.
TANK WAGON FILLED HERE.
HYDRANT
TANK C.
(WELL 165 FEET)
HOUSE
STOCK
TANK A
BARNS.
BLOCK
BLOCK
BARN
E C I G
(3)
A L D B
(AUG 15)
RAILROAD SHEDS
INTERURBAN STREET RAILWAY
RAILROAD
ROUGH PLOT OF CAMP OF THE 15th MINNESOTA AT CAMP RAMSEY IN THE STATE FAIR GROUNDS.

The medical history, as prepared by the board, covers a period of 5 months and 26 days. Of this time, 49 days were spent in Camp Ramsey, the State camp, near St. Paul, Minn., 41 of these upon the first camp site and 8 upon the second site; 23 days encamped upon the Government reservation at Fort Snelling, Minn.; 59 days at Camp Meade, the national camp in Pennsylvania; 33 days in Camp Mackenzie, the national camp near Augusta, Ga.

This regiment furnishes a most striking example of rapid prostration by the ravages of typhoid fever before arrival in the national camp of rendezvous. Nearly the whole of its exceedingly extensive infection occurred before its arrival at Camp Meade, Pa. Indeed, there was scarcely any new typhoid-fever infection after arrival there, for nearly all the comparatively few cases developed in Camp Meade were undoubtedly infected before arrival there. This great epidemic was, therefore, practically extinguished before the departure of the regiment from the national camp in Pennsylvania for the national camp in the South.

With respect to the origin of this extraordinary epidemic, besides what has already been advanced in the foregoing communications, it may be well to know something of the early history of the Twelfth and Fourteenth Minnesota regiments of the first call, which preceded the Fifteenth at Camp Ramsey, the Twelfth, as already stated, having previously occupied the same camp site. Although the respective surgeons of these two regiments do not admit the existence of typhoid fever while at Camp Ramsey, the details of the medical histories of these two regiments, as obtained by the board, indicate that both the Twelfth and Fourteenth Minnesota regiments arrived at the national camps in Chickamauga Park already infected with typhoid fever. (See their histories under Chickamauga Park.)

Development of typhoid fever and related sickness.—The following is a statement, arranged in tabular form for easier and more rapid examination and classification, of fevers (including typhoid) and intestinal disorders which have been regarded by the board as essentially involved in a just estimation of the prevalence of typhoid fever. In all cases the dates given of the beginning of attacks were recorded as closely as they could be ascertained.

[Mean strength, 1,280.]

	Intestinal disorders.				Febrile attacks.		Typhoid attacks.		Total probable typhoid, including malarial.	Deaths from disease.	
	Short, 1-4 days.	Long, 5-9 days.	Prolonged, 10+ days.	Total attacks.	Short, 1-9 days.	Long, 10+ days.	Probable.	Certain.		Typhoids.	All others.
July	67	2	1	70	.....	.....	.....	1	1	.....	.....
August	140	21	2	163	.....	.....	17	270	287	.....	.....
September	62	10	3	75	23	2	22	136	160	5	.....
October	43	8	4	55	65	6	7	6	19	11	.....
November	12	3	2	17	44	5	2	1	8	2	.....
December	8	6	.....	14	14	1	.....	1	2	.....	.....
Total	332	50	12	394	146	14	48	415	477	18	.....

A rectification of the total number of so-called long malarias, as given in the above summary table, should be made by reducing the total of 14 to 12, thus requiring a corresponding reduction of the number of probable typhoid-fever attacks from 477 to 475.

The above tabulated deaths from disease, by months, were distributed among the companies as follows: Typhoid, Company E, 2; Company F, 1; Company G, 6; Company H, 3; Company I, 1; Company K, 1; Company L, 1; Company M, 3; total, 18. Other diseases, none.

The following is a series of three tables, showing by companies, respectively, the attacks of typhoid fever, of so-called malaria, etc., and of intestinal disorders in individuals (*a*) who have no other recorded attacks (of the categories we have been considering), and (*b*) who have had such other attacks:

Intestinal disorders.

	Single short diarrhea.	Two attacks short diarrhea.	Short and long diarrhea.	Short and prolonged diarrhea.	Single long diarrhea.	Two attacks long diarrhea.	Prolonged diarrhea.	Prolonged and long diarrhea.	Total diarrhea.
Company A	21	2			2				37
Company B	9	6			1	2			41
Company C	19	6			1				39
Company D	17	5	1		5		1		41
Company E	19	4			1	1			39
Company F	14	1			1				22
Company G	2				2				15
Company H	10	1			1				22
Company I	20	3			1				24
Company K	14	4	2		1		2	1	40
Company L	5	3	1		1		1		17
Company M	20	2	1	1	1	2	1		46
Unassigned							1		1
Total	170	37	5	1	18	5	6	1	394

Total diarrhea includes diarrhea in malaria and typhoid combinations.

Combinations of continued or malarial fever.

	Short malaria (uncombined).	Short malaria preceded by diarrhea.	Long malaria (uncombined).	Long malaria preceded by diarrhea.	Two attacks long malaria preceded by diarrhea.	Total short malaria.	Total long malaria.
Company A	7	1		2		8	2
Company B	10	2				16	1
Company C	9	1	4			13	4
Company D	8	1	1			9	1
Company E	11	2				14	
Company F	9					12	
Company G	13	2	1			21	1
Company H	5	4	2			13	1
Company I	10	2			1	13	2
Company K	10					13	
Company L	3	1				4	
Company M	8		1	1		10	2
Total	103	16	9	3	1	146	14

Totals include malaria in typhoid combinations.

Combinations of typhoid fever.

	Certain typhoid (uncombined).	Probable typhoid (uncombined).	Typhoid beginning in diarrhea.	Probable typhoid beginning in diarrhea.	Typhoid preceded by diarrhea.	Probable typhoid preceded by diarrhea.	Typhoid followed by diarrhea.	Typhoid preceded by malaria.	Typhoid followed by malaria.	Probable typhoid followed by malaria.	Combinations of three diseases.	Total certain typhoid.	Total probable typhoid.	Total probable and certain typhoid.
Company A	21	3	2	------	6	------	------	------	------	------	------	29	3	32
Company B	23	2	------	------	6	1	------	------	2	------	------	31	3	34
Company C	7	2	1	------	2	1	1	------	2	------	1	14	3	17
Company D	24	3	1	------	1	2	1	------	------	------	------	27	5	32
Company E	20	3	2	------	5	------	1	------	1	------	------	29	3	32
Company F	34	3	1	------	3	1	------	------	1	1	1	40	5	45
Company G	41	2	2	1	7	1	------	------	5	------	1	56	4	60
Company H	48	2	3	------	4	1	------	------	4	------	------	59	3	62
Company I	21	1	1	------	2	1	------	------	1	------	------	25	2	27
Company K	36	2	------	------	6	------	3	------	1	------	------	46	2	48
Company L	20	5	------	------	1	------	------	------	------	------	------	21	5	26
Company M	25	8	------	------	6	1	1	------	2	------	2	36	9	45
Unassigned	2	------	------	------	------	------	------	1	------	------	------	2	1	3
Total	322	36	13	1	49	9	7	1	19	1	5	415	48	463

The records of sickness in this regiment were found to be more or less incomplete and to some extent conflicting. By way of illustration: There are 14 names of soldiers in this regiment in the hospital records which were not found in the regimental sick report; and vice versa, there are 7 names of soldiers entered upon the regimental records as having been sent to the division hospital which have not been discovered in the reports of the latter. Furthermore, there are 9 cases of so-called short malaria of which there are no final dispositions recorded. How many of these were really typhoid fever and should have been added to the total number of probable typhoid fever attacks given in the above summary table we could not determine. That there were some we think can not be reasonably questioned. Moreover, we have encountered 2 fatal cases of typhoid fever of which the only record of sickness found was the death return to the Adjutant-General's Office. The foregoing tabular statement of sickness should be regarded as a conservative estimate of the prevalence of typhoid fever in this regiment.

The salient points of the medical history (including morbidity and mortality) of the Fifteenth Minnesota Infantry as a member of the Third Brigade and First Division of the Second Army Corps, as at Camp Meade, Pa., may be recapitulated in the following condensed form:

(*a*) The regiment was in its State camp, in the fair grounds near St. Paul, Minn., from July 5 to August 23, having changed camp site August 15; it was on the United States Government reservation at Fort Snelling from August 23 to September 15; it was in Camp Meade,

the national camp in Pennsylvania, from September 18 to November 16; it was in the national camp near Augusta, Ga., from the 18th of November until the 31st of December, 1898, and it was mustered out at the latter place March 27, 1899. The initial date of the first probable attack of typhoid fever was July 30; of the first certain attack of typhoid fever was August 3. A quite sudden outbreak of typhoid fever, at first limited to certain companies, occurred at the State camp. This caused first a change of camp site and soon after the removal of the regiment from the State fair grounds near St. Paul to Fort Snelling, but the epidemic assumed still larger proportions for a while. Although by the date of the departure of the regiment for the national camp in Pennsylvania this epidemic had already begun to rapidly decline, it carried with it the infection very widely diffused among the companies. The medical history as given by the board covers a period of five months and twenty-six days (from July 5 to the 31st of December, 1898), and it is epitomized in the succeeding numerical data.

(*b*) Attacks of intestinal disorder, 394; of so-called malaise, short malaria, etc., 146; of so-called malaise, long malaria, etc., 12; of probable typhoid fever, 48; and of certain typhoid fever, 415. Total attacks of probable typhoid fever (long malaria, etc., included), 475.

(*c*) Total deaths from typhoid fever, 18; total deaths from all diseases, 18; mortality per cent of total probable typhoid fever attacks, 3.78; of total certain typhoid fever attacks, 4.33; per cent of total typhoid deaths to total deaths from all diseases, 100.

(*d*) The mean strength was 1,280. The per cent of typhoid morbidity to mean strengh as to total probable typhoid fever attacks was 37.10, while the average for the division was 22.57; as to total certain typhoid fever attacks was 32.42, while the average for the division was 15.42. The number of typhoid deaths per 1,000 of mean strength was 14.06; the average for the division was 12.55.

We have endeavored to ascertain the average age (in years) of sick soldiers, grouped by the diseases we have been studying, as well as of soldiers who have died of typhoid fever, and we have obtained the following figures as to the Fifteenth Minnesota Infantry:

(*a*)	Of short intestinal disorders in 201 individuals, average age	25.8
	Of long intestinal disorders in 22 individuals, average age	25.2
	Of prolonged intestinal disorders in 9 individuals, average age	21.8
	Of the total intestinal disorders in 232 individuals, average age	25.5
(*b*)	Of short malaria, etc., in 60 individuals, average age	25.5
(*c*)	Of long malaria, etc., in 14 individuals, average age	20.9
	Of probable and certain typhoid attacks in 444 individuals, average age	24.0
	Of total probable and certain typhoid and long malaria in 458 individuals, average age	23.9
(*d*)	Of grand total all above classes in 750 individuals, average age	24.4
(*e*)	Of 11 soldiers who died from typhoid fever, the average age	24.8

For comparison of these average age figures with similar data relative to other regiments in the division, we refer to the general tables treating of this subject at the end of the Second Army Corps at Camp Meade, Pa. (See, also, similar tables relating to the regiments of the Second Division of the Seventh Army Corps at Jacksonville, Fla.)

Peculiar but general characteristics of company epidemics as exhibited in the graphic chart.—(*a*) It is only when we study the course of sickness in the regimental organizations from the standpoint of individual companies that we can adequately appreciate the fact that the course of disease in the regiment is characterized by a series of company epidemics, each one having more or less perfectly its own individual characteristics. It is especially true when we regard the commencement, the exacerbations during the course, and the time of the termination of the company epidemics that they are rarely seen to be synchronous. Not only are there variations in these company epidemics considered as integral parts of the regimental organization, but there is, as a rule, no striking similarity in the course of the epidemics even in the companies grouped together in battalion organizations. The history of typhoid fever among the companies of this organization furnishes more examples of the exceptions to the general rules just enunciated than perhaps does any other regiment in the whole volunteer army which has been studied by the board from the standpoint above mentioned. This is due, no doubt, to the fact, as shown by the foregoing history of disease in this regiment, that at least four of the companies, H, M, K, and F, inaugurated the experience of the regiment with typhoid fever by sudden and nearly simultaneous epidemic outbreaks of the disease. Reference to the accompanying diagram maps of the camps of this regiment shows that these companies, however, were in separate battalions, only two of them being adjoining companies in the middle battalion; and even in these four companies which had a synchronous beginning the subsequent course of the disease was dissimilar. While with the four companies mentioned we may assume that there was a common origin of the epidemics, we can not infer the existence of a common, simultaneous, and more or less continuously acting agency as the chief means of propagation even in these epidemics. And as to the other companies of this regiment, the dissimilarities in the time of beginning and the course of the company epidemics, as well as their ending, would appear to be incompatible with the assumption of a common, simultaneous, and more or less continuously acting agency as the chief means of origin and propagation of typhoid fever. Reference to the graphic chart gives ample evidence of these truths, and it is not necessary to illustrate further by entering into details.

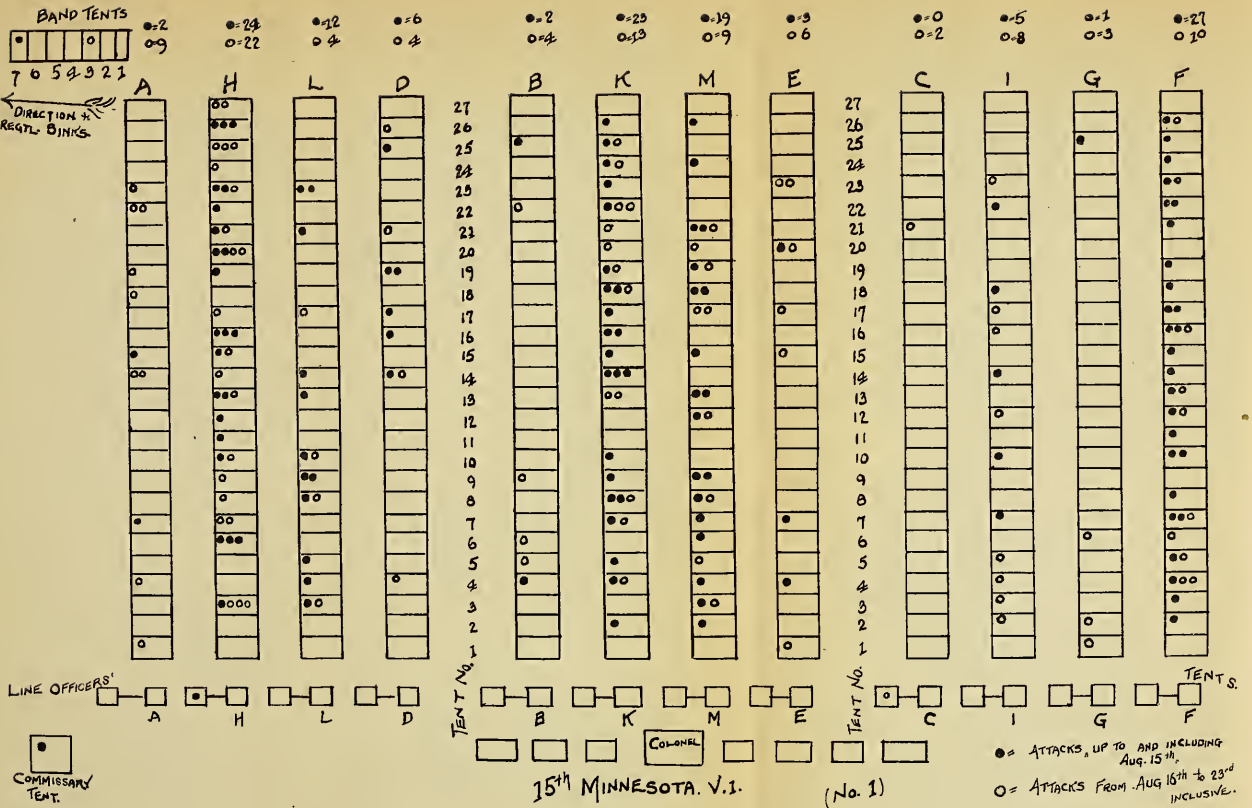
(*b*) The company epidemics have frequent greater or less exacerbations in their course, and the intervals between these exacerbations are as a rule closely coincident with the average period of incubation

of typhoid fever. A close examination from this standpoint of the foregoing tabular statement and of the graphic chart will more or less definitely substantiate this statement. The truth of it becomes especially evident if, instead of recording the course of typhoid fever by Arabic numerals in the foregoing tabular form, we indicate each individual attack by a dot corresponding to the proper date.

Special characteristics of company epidemics from the standpoint of local or peculiar influences.—(*a*) Reference to our first diagram map representing the first camp of the Fifteenth Minnesota Infantry at Camp Ramsey, in the fair grounds near St. Paul, Minn., in which we have indicated the order and relation of the different companies of this camp, as well as the number of attacks of typhoid fever in the various tents, will show that the four companies, H, K, M, and F, which experienced almost simultaneously the first sudden outbreak of typhoid fever, were distributed among the three battalions, only two of them, K and M, adjoining each other in the center battalion, while Company F was on the extreme eastern flank of the regiment and Company H was the company next to the extreme western flank. With reference to the location of the regimental latrine it is seen that there is a great diversity in the location of these four first-affected companies. Since there was only one large regimental latrine for the use of all companies in this camp, mere reference to the relative location of these companies in the regimental camp and the location of the latrine some distance from the extreme western flank of the camp would appear to be sufficient to cast in doubt any common agency of wind or flies playing a chief role in the origin or dissemination of the infection of typhoid fever throughout these companies, since neighboring or intervening companies of the battalions did not participate in a common experience.

(*b*) Attention is called to the fact that when the regiment departed from Camp Ramsey in the fair grounds on August 23 Company G was left behind for one day to police the abandoned camps, this company up to that time having been entirely free from serious disease. The first outbreak in this company was a severe one, occurring on August 25, followed by a continuance of the severe epidemic for three weeks or more. It may be remarked here that this company was not mustered in until July 16.

(*c*) It may also be remarked that when on August 15, owing to the serious spread of typhoid fever, the first camp of the regiment was abandoned, the four severely affected companies, K, M, F, and H, were moved to new and higher ground near the first camp; the other companies, at this time little affected, were moved to a new site at a considerable distance on new and high ground, still within the fair grounds near St. Paul. When on August 23 the regiment was moved from Camp Ramsey to Fort Snelling, Minn., the badly affected companies, K, M, F, and H, were placed in an isolated camp some 2


BAND TENTS
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A
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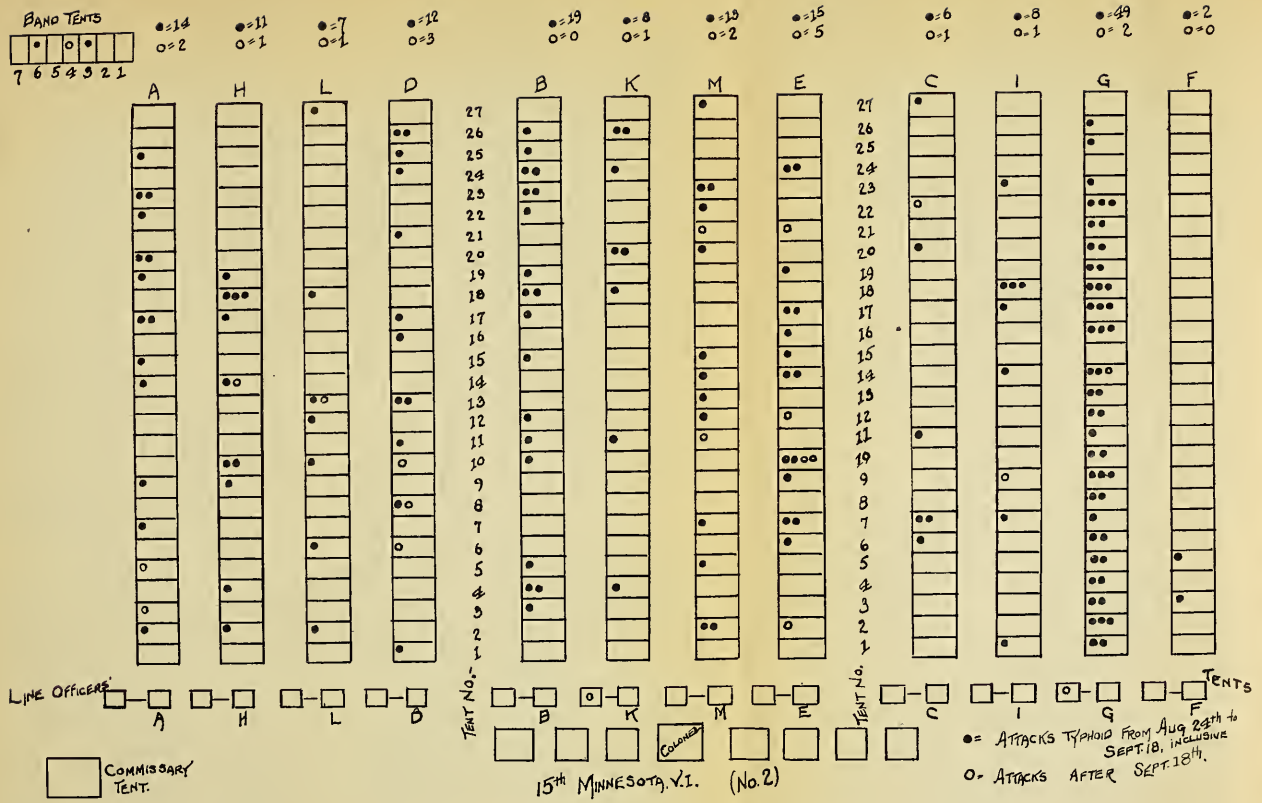
DIRECTION OF REGTL. BKS.
TENT No.
LINE OFFICERS'
TENTS.
COLONEL
COMMISSARY TENT.
15th MINNESOTA. V.1.
(No. 1)
● = ATTACKS, UP TO AND INCLUDING Aug. 15th.
○ = ATTACKS FROM Aug 16th to 23rd INCLUSIVE.


BAND TENTS
7 6 5 4 3 2 1
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●=11 ○=1
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●=12 ○=3
●=19 ○=0
●=8 ○=1
●=13 ○=2
●=15 ○=5
●=6 ○=1
●=8 ○=1
●=49 ○=2
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TENT No.-
LINE OFFICERS'
TENTS
COLONEL
COMMISSARY TENT.
●= ATTACKS TYPHOID FROM AUG 24th to SEPT. 18, INCLUSIVE
○- ATTACKS AFTER SEPT. 18th.
15th MINNESOTA. V.I. (No. 2)

miles from the general camp at Fort Snelling for about six days, after which time they joined the camp of the regiment, because of the fact that the infection had by that time become very generally disseminated among the other companies.

Special characteristics of certain company epidemics as exhibited by general limitation of sickness to certain squads of men as they were grouped in tents, viewed from the standpoint of a possible tent, squad, or comrade infection.—(*a*) We have endeavored to ascertain the names of soldiers as they were grouped in their tents during the periods of encampment of this regiment at the State fair grounds near St. Paul, and at Fort Snelling, Minn., as well as at Camp Meade, Pa., in order to examine into this important question. To this end we have requested such data from two different sources, namely, from the regimental surgeon and from the commanding officers of the companies. The regimental surgeon in response to this request furnished a diagram map of the camps of the Fifteenth Minnesota, in which the number of attacks of typhoid fever in individual tents of companies was indicated. He also furnished a list of names of the men of each company as they were grouped together in their tents. With the data thus obtained we have constructed two diagram maps, showing the order and relationship of the companies in their camps and the number of cases of typhoid fever which developed during four different periods. In the first map the attacks of typhoid fever up to August 15, when the regiment first changed its camp, are indicated by one sign; those occurring from August 16 to 23, on which latter date the regiment moved from the State fair grounds to Fort Snelling, by another sign. In the second map the attacks of typhoid fever in two periods are represented, one sign representing the period during which the regiment was encamped at Fort Snelling, and the other sign representing the last period, beginning when the regiment reached the national camp, Camp Meade, Pa., September 18. Reference to these maps shows the manner in which the attacks of typhoid fever were grouped with regard to certain tents. The squad groups of the sick as plotted in their tents would seem to be incompatible with the assumption that the chief factor in the propagation of typhoid fever throughout the companies of this regiment may have been some agency whose influence was common and pretty constantly acting upon the whole command; on the contrary, they would appear to suggest a mode of disseminating infection which more effectively reached and acted upon certain limited groups of men, while it passed by others, which would be entirely compatible with the assumption of a dominating tent, squad, or comrade infection. Whatever the origin of the epidemic might be, whether a water infection, for example, which acted upon four companies simultaneously and not upon other companies of the regiment, in the course of the subsequent epidemic some other mode of infection became dominant sooner or later and

gave rise to dissimilarities even in those companies where the original infection may have been simultaneous.

(*b*) A further indication of the existence and active influence of a tent, squad, or comrade infection throughout this command is the following result of a careful analysis we have made of the records of sickness in this regiment in connection with the grouping of infected men in their tents and the average time elapsing between successive or "connectable" attacks in the same tent and in adjoining tents. As deduced from the surgeon's tent lists, we find that among 436 cases of typhoid fever platted in their respective tents 317, or 72.70 per cent, were separated or "connectable" by periods which could fairly be regarded as measuring the average period of incubation of typhoid fever.

Estimation of the average length of the period of incubation of typhoid fever.—We have endeavored to calculate the average period of incubation of this disease from data obtained from two different sources, and we have found a striking coincidence in the average of the figures thus obtained:

(*a*) Period of incubation as deduced from the length of intervals between "connectable" attacks of typhoid fever occurring in the same or in adjoining tents. As deduced from the surgeon's tent lists among 436 attacks of typhoid fever as plotted in their respective tents, there were 214 intervals between attacks which could fairly be regarded as measuring the length of an average period of incubation. The average lengths of these 214 intervals was 10.2 days.

(*b*) Period of incubation as deduced from the length of intervals between attacks of diarrhea preceding typhoid fever and the development of the typhoid fever attacks. The Fifteenth Minnesota furnished 26 examples of attacks of diarrhea preceding typhoid fever by periods which could fairly be regarded as measuring a period of incubation. The length of the intervals in these cases averaged 11.7 days.

N. B.—For similar data concerning other regiments of this corps and of the regiments of the Second Division, Seventh Army Corps, see tables relating to this subject under the respective corps.

Average length of disability from typhoid fever.—The fullness and completeness of the records concerning typhoid fever in the Fifteenth Minnesota Infantry furnished an opportunity for an endeavor to ascertain the average length of disability from typhoid fever in a military command in active service in the field. An analysis of 326 cases, of which the records were complete—that is, the lapse of time between the recorded beginning of the attack and the date of return to duty—shows the average to be 66 days. These 326 cases were distributed as follows: First class comprised 179 attacks occurring anterior to the 25th of August (ten days after the removal of the regiment from its first camp site). The average disability in this class was 70 days. Second class, attacks occurring between August 26 and September 3 (ten days, respectively, after the commencement and end of the sec-

ond camp at Camp Ramsey). Seventy-seven attacks occurred during this period which averaged 64 days of disability. Third class, September 4 to September 29 (ten days, respectively, after the commencement and end of the regiment's encampment at Fort Snelling). This period embraced 66 attacks of typhoid fever whose average disability was 67 days each. Fourth class, after September 29 (ten days after the arrival of the regiment at the national camp at Camp Meade). This period embraced 4 cases, whose disability averaged each 42 days. It is thus seen that the length of average disability was much shorter in those cases infected in the national camp than in the cases infected in earlier camps. (See also general table relating to this matter under the Second Army Corps at Camp Meade.)

In this regiment (the Fifteenth Minnesota) the average length of disability caused by typhoid fever attacks was ascertained in 326 cases. These cases are considered under four groups or classes, viz:

1. Attacks which occurred before August 25	179
2. Attacks which occurred from August 26 to September 3	77
3. Attacks which occurred from September 4 to 29	66
4. Attacks which occurred after September 29	4
Total	326
Average days of disability in group 1	70
Average days of disability in group 2	64
Average days of disability in group 3	67
Average days of disability in group 4	42
Average days of disability in all four groups	68

The instances in which 3 or more typhoid attacks occurred in the same tent were 81, distributed in the four groups as follows:

1. Attacks which occurred before August 25	42
2. Attacks which occurred from August 26 to September 3	22
3. Atttack which occurred from September 4 to 29	15
4. Attacks which occurred after September 29	2
Total	81
Average of days of disability in group 1	70
Average of days of disability in group 2	67
Average of days of disability in group 3	69
Average of days of disability in group 4	46
Average of days of disability in all four groups	68

CONSIDERATION BY THE BOARD OF TYPHOID FEVER IN THE FOURTH NEW JERSEY INFANTRY.

Brief outline of the medical history.—This is a second-call regiment which assembled and was mustered at the State camp by the shore of the sea at Seagirt, N. J., on the 19th of July, 1898, and remained encamped there until the 8th of October, on which latter date it started by rail for the national camp near Middletown, Pa. The next day the command reached Camp Meade, Pa., was assigned to the First Brigade, Second Division of the Second Army Corps, as at Camp Meade, and went into camp with the Two hundred and third New York and Second West

Virginia, the two other members of this brigade which came direct to Camp Meade from their respective State camps. It should be remarked that the Two hundred and third New York had already been removed to an isolation camp 8 miles away before the arrival of the Fourth New Jersey. (See history of the Two hundred and third New York.) The One hundred and fifty-ninth Indiana, Twenty-second Kansas, Third New York, and Eighteenth Pennsylvania were for a time attached to the same brigade, under orders to be mustered out. (See histories of these regiments under Camp Alger.) The Fourth New Jersey remained at Camp Meade, Pa., until the 12th of November, when it left by rail for Camp Wetherill, near Greenville, S. C., where it arrived on the 14th. It was still at Camp Wetherill on the 31st of December, 1898, and was mustered out of the service of the United States on the 6th of April, 1899, at Greenville, S. C.

The medical history of this regiment as prepared by the board covers a period of five months and twelve days. Of this time eighty-one days were spent in the State camp at Seagirt, N. J., thirty-four days at the national camp, near Middletown, Pa., and forty-seven days in Camp Wetherill, near Greenville, S. C.

In his testimony before the board the surgeon in charge of the regiment admits the development of a case of typhoid fever two days after the arrival of the regiment at Camp Meade, the first case of the disease recognized as such by him. This case was of course infected some days before the arrival of the command at the national camp in Pennsylvania. Moreover, an examination of the following details of sickness in this regiment abstracted from the available records shows that there were 4 attacks regarded by the board as probably typhoid, which developed respectively on the 2d, 7th, 24th, and 28th of September. In connection with these 4 September attacks it should be remembered that about the last of August the First New Jersey returned to its State camp at Seagirt from Camp Alger, Va., with 20 soldiers suffering from typhoid fever, and that about the 25th of September the Second New Jersey returned to the same State camp from the national camp at Jacksonville, Fla., suffering greatly from typhoid fever and carrying with it, according to the surgeon of the Fourth New Jersey, 60 cases of typhoid fever and leaving behind in Florida as many more sick in hospital. The Second New Jersey adjoined the Fourth New Jersey in the State camp and the men of all three regiments freely intermingled. Prior to the return of the First New Jersey and Second New Jersey from the respective national camps where they had become infected with typhoid fever it is probable that there was no such infection in the State camp at Seagirt, unless indeed we may suspect that a case of continued fever developing on the 2d of August in the Fourth New Jersey was really a typhoid attack rather than of malarial character, as diagnosed by the surgeon. Whether the typhoidal infection certainly existing in the Fourth New Jersey anterior to its arrival at Camp Meade was indirectly chargeable to

camps Alger and Cuba Libre, or developed independent of that existent source of infection, this regiment must, in view of the foregoing, be classed with those which have brought from their State camps the infection of typhoid fever. Carrying with it into the national camp the infection of typhoid fever, the Fourth New Jersey presents one of the very few examples in this whole campaign of a regiment having started with the infection yet escaping the subsequent development of an epidemic of typhoid fever.

Development of typhoid fever and related sickness.—The following is a statement arranged in tabular form for the easier and more rapid examination and classification of fevers, including typhoid, and intestinal disorders which have been regarded by the board as essentially involved in a just estimation of the prevalence of typhoid fever. In all cases the dates of the beginning of attacks were recorded as closely as they could be ascertained:

[Mean strength, 1,225.]

	Intestinal disorders.				Febrile attacks (malaria, etc).		Typhoid attacks.		Total probable typhoid including malaria.	Deaths from disease.	
	Short, 1-4 days.	Long, 5-9 days.	Prolonged, 10 + days.	Total attacks.	Short, 1-9 days.	Long, 10 + days.	Probable.	Certain.		Typhoids.	All others.
July	29	1	------	30	2	------	------	------	------	------	------
August	35	4	------	39	13	1	------	------	1	------	------
September	45	6	------	51	5	------	2	2	4	------	------
October	39	5	2	46	3	1	1	2	4	------	------
November	5	1	1	7	3	------	2	2	4	------	------
December	19	------	1	20	------	------	------	------	------	------	------
Total	172	17	4	193	26	2	5	6	13	------	2

Two "other deaths" in February, 1899. No typhoid deaths.

MALARIAL DISEASES AT CAMP MEADE, PA.

With regard to the prevalence of malarial fevers at this camp, we may state that having followed with much care the cases of malarial fever reported by the medical officers of the thirteen regiments whose histories are here given, we have found the diagnosis in a large majority of cases admitted to division hospitals afterwards changed to that of typhoid fever. This would appear to indicate that malarial fevers were not prevalent at Camp Meade. Concerning this matter Acting Asst. Surg. George Dock, who visited this camp during the third week in September for the purpose of making blood examinations, says:

When I arrived at Camp Meade I found comparatively few cases with the diagnosis of malaria in the Second Division hospital. Most of the surgeons claimed that malarial disease was very rare there. I found two wards, the so-called malarial wards (3 and 4), in which a great many cases had the diagnosis of malaria. I examined the blood of many of these, also of many recently admitted men and some suspicious cases in other wards, to the number of 20, but without finding any parasites. As the bacteriological outfit was incomplete, Widal tests could not be made, but out of the so-called malarial cases at least two-thirds were

evidently typhoid in the middle stage, some not yet definitely recognizable, and some convalescent.

In the first division hospital I was told there were a great many cases of malaria and typho-malarial fever. Several so-called typical cases of the latter had no parasites, and were evidently uncomplicated cases of typhoid fever. One case proved to be malaria, and is quite as instructive as the positive case found at Chickamauga. Private B, Company F, Fifteenth Pennsylvania Infantry, came two weeks before examination from Sheridan Point on the Potomac River. Four days later he began to have chills, and had, so far as he knows, three chills. He felt quite well the free days. The temperature had not been taken often enough to give the type. There had been a chill the day before examination, and the patient had taken 24 grains of quinine in two days. Soon after beginning the examination I found an organism almost filling a red blood corpuscle.

Like the case previously described, at Chickamauga, he came to camp already infected. To summarize: I found remarkably little evidence that malaria was prevalent in Camp Meade, the only case found being imported.

The evidence of so competent an observer, based on blood examinations made at Camp Meade, is of great importance in determining the slight part which malaria played as a factor in the fevers at this camp. We have been inclined to look upon many of these short (less than ten days) fevers, of supposed malarial character, as really cases of mild infection with the typhoid bacillus.

We have already given the result of our investigations bearing on this point in nineteen regiments of the Second Army Corps, at Camp Alger, Va. We have repeated the same patient investigation of the subsequent history of all of these supposed malarial fevers in thirteen regiments of this corps at Camp Meade, Pa., in order to ascertain whether these men possessed a relative immunity to typhoid fever as compared with those men who did not experience these milder fevers. The results are given in the following table:

Cases of typhoid fever among men with and without preceding malarial diseases in thirteen regiments Second Army Corps, at Camp Meade, Pa.

Regiment.	Mean strength.	Cases of malaria.	Cases of malaria followed by typhoid fever.		Number of men without preceding malaria.	Typhoid cases without preceding malaria.		Total cases of typhoid fever.
			Number of cases.	In 100 malarial cases.		Number of cases.	In 100 men who have not had malaria.	
3d Connecticut	1,214	39	.....	.....	1,175	152	12.9	152
1st Delaware	926	70	2	2.9	856	43	5.0	45
1st Maryland	1,251	41	.....	.....	1,210	85	7.0	85
5th Massachusetts	1,275	108	.....	.....	1,167	53	4.5	53
35th Michigan	1,150	171	6	3.5	979	313	31.9	319
15th Minnesota	1,280	112	.....	.....	1,168	463	39.6	463
4th New Jersey	1,225	23	.....	.....	1,202	11	.9	11
201st New York	1,076	196	13	6.7	880	160	18.2	173
202d New York	1,125	222	10	4.5	903	140	15.5	150
203d New York	1,047	153	26	17.0	894	454	50.8	480
10th Ohio	1,288	157	8	5.1	1,131	253	22.4	261
2d Pennsylvania	1,070	54	.....	.....	1,016	5	.5—	5
2d West Virginia	1,165	84	7	8.3	1,081	173	16.0	180
Total	15,092	1,430	72	5.0	13,662	2,305	16.9	2,377

That is: Of 1,430 individuals who were treated for malaria 72, or 5 per cent, subsequently had typhoid fever.

Of 13,662 men who were not treated for malaria 2,305, or 16.9 per cent, had typhoid fever.

Or: Of 2,377 cases of typhoid fever 72, or 3 per cent, had previously been treated for malaria.

Of 2,377 cases of typhoid fever 2,305, or 97 per cent, had no preceding malaria.

We therefore conclude that malarial diseases were rare at Camp Meade, and that a majority of the milder fevers, so designated, were really manifestations of infection with typhoid bacillus.

THE RELATION OF INTESTINAL DISORDERS TO TYPHOID FEVER.

We have given, under the Second Army Corps, at Camp Alger, Va., the result of our investigations with regard to the predisposition to typhoid fever which intestinal disorders are supposed to favor. We have there drawn the conclusion that, contrary to the generally accepted opinion, these intestinal disorders not only do not favor the development of typhoid fever in the affected individuals, but that they bring about a relative immunity to typhoid attacks. The following table will show that the same conclusion can be drawn from our investigations at Camp Meade:

Cases of typhoid fever among men with and without preceding diarrheal diseases in the thirteen regiments of the Second Army Corps, at Camp Meade, Pa.

Regiment.	Mean strength.	Cases of diarrheal diseases.		Cases of diarrhea followed by typhoid fever.		Number of men without preceding diarrhea.	Typhoid fever cases without preceding diarrhea.		Total cases of typhoid fever.
		Number of cases.	Number of individuals.	Number of cases.	In 100 men with preceding diarrhea.		Number of cases.	In 100 men not having had diarrhea.	
3d Connecticut	1,214	35	35	5	14.3	1,179	147	12.5	152
1st Delaware	926	49	48	.....	.....	878	45	5.1	45
1st Maryland	1,251	27	24	1	4.2	1,227	84	6.8	85
5th Massachusetts	1,275	205	190	4	2.1	1,085	49	4.5	53
35th Michigan	1,150	188	178	15	8.4	972	304	31.3	319
15th Minnesota	1,280	346	291	36	12.4	989	427	43.2	463
4th New Jersey	1,225	168	152	1	.6	1,073	10	.9	11
201st New York	1,076	198	188	21	11.2	888	152	17.1	173
202d New York	1,125	109	100	6	6.0	1,025	144	14.0	150
203d New York	1,047	162	151	47	31.1	896	433	48.3	480
10th Ohio	1,288	318	286	42	14.7	1,002	219	21.85	261
2d Pennsylvania	1,070	236	207	1	.5—	863	4	.46	5
2d West Virginia	1,165	7	7	.....	.....	1,158	180	15.5	180
Total	15,092	2,048	1,857	179	9.1	13,235	2,198	16.6	2,377

That is: Of 1,857 individuals who were treated for intestinal complications 179, or 9.1 per cent, subsequently had typhoid fever.

Of 13,235 men who had not been treated for intestinal complications, 2,198, or 16.6 per cent, had typhoid fever.

Or: Of 2,377 cases of typhoid fever, 179, or 7.5 per cent, had previously been treated for diarrhea.

Of 2,377 cases of typhoid fever, 2,198, or 92.5 per cent, had no previous intestinal complications.

ORIGIN AND SPREAD OF TYPHOID FEVER IN THE SECOND ARMY CORPS AT CAMP MEADE, PA.

Every regiment that arrived at this national camp, whether coming from another general encampment, such as Camp Alger, Va., or direct from State camps, imported typhoid fever. There was no exception to this general statement. Of 25 regiments that reached this camp during the latter half of August and the first half of September, 18 were thoroughly infected with typhoid fever and 7 had already had

from 2 to 8 cases of this disease. The origin of typhoid fever at Camp Meade is therefore clear.

For the course of the disease in the several organizations during the period August 15 to November 15, 1898, the period of occupancy of Camp Meade, the regimental history and the graphic charts should be consulted. From a study of these it will be seen, as we have already repeatedly had occasion to remark in our summary of regimental histories, that typhoid fever at Camp Meade, as elsewhere, consisted essentially of a series of company epidemics, each one having more or less perfectly its own individual characteristics. The dissimilarities in the time of beginning and the course of the company epidemics, as well as their ending, would appear to be incompatible with the assumption of a common, simultaneous, and more or less continually acting agency as the chief means of origin and propagation of typhoid fever. Reference to the graphic charts gives ample evidence of these truths, and it is not necessary to illustrate further by entering into details. The course of typhoid fever in the various companies forming the regiments of the First and Second Divisions of the Second Army Corps at Camp Meade, Pa., was such as to conclusively eliminate any contamination of the general or company water supply.

We have already shown in the case of the Thirty-fifth Michigan, Fifteenth Minnesota, and Two hundred and third New York Infantry the result of our endeavors to ascertain the names of soldiers developing typhoid fever as they were grouped in their tents in the several camps. (For details see histories of these regiments.) Reference to the diagrams accompanying these regiments will show the manner in which the attacks of typhoid fever were grouped with regard to certain tents. These squad groups of the sick, as plotted in their tents, would appear to suggest a mode of disseminating infection which effectively reached and acted upon certain limited groups of men while it passed by others. This would be, we think, entirely compatible with the assumption of a dominating tent, squad, or comrade infection. This would seem to hold true of any company epidemic which persists for any considerable time, whatever may have been the mode of the original infection. We have already stated under the head of general remarks that the general police of the regimental camp sites was excellent, and that the care of the company sinks, as regards the immediate covering of all excreta, was very satisfactory. We do not doubt that, notwithstanding these sanitary precautions, there were individual instances of what we have designated as sink infection, or that food was occasionally infected by flies. We believe, however, that squad or comrade infection was probably the most important factor concerned in the spread of typhoidfever at Camp Meade, Pa.

General table showing number and per cent of connectable typhoid attacks in tents (as deduced from surgeons' tent lists) in three regiments of the Second Army Corps at Camp Meade, Pa.

Regiment.	Attacks plotted.	Directly connectable attacks (in same tents).	Per cent of connectable to all attacks plotted.	Indirectly connectable attacks (in next tents).	Per cent of connectable to all attacks plotted.	Regimental totals (direct and indirect).	Per cent of connectable to all attacks plotted.	Grand total.	
								Number of connectable attacks of those plotted	Per cent of connectable to all attacks plotted
35th Michigan	189	59	31.21	65	34.39	124	65.60	.....	.....
15th Minnesota	436	199	45.64	118	27.06	317	72.70	.....	.....
203d New York	467	106	22.69	128	27.41	234	50.10	.....	.....
Grand total	1,092	364	33.33	311	28.48	.....	.....	675	61.81

Table showing number and per cent of connectable typhoid fever attacks in tents (as deduced from captains' tent lists) in certain companies of two regiments of the Second Army Corps at Camp Meade, Pa.

Regiment.	Company.	Attacks plotted.	Directly connectable attacks in same tents.	Per cent of connectable to all attacks plotted.	Indirectly connectable attacks in next tents.	Per cent of connectable to all attacks plotted.	Company totals (direct and indirect).		Regimental totals.	
							Number of connectable attacks.	Per cent of connectable to all attacks plotted.	Number of connectable attacks.	Per cent of connectable to all attacks plotted.
35th Michigan	A	45	23	51.11	13	28.89	36	80.00	.....	.....
	L	29	7	24.13	8	27.50	15	51.73	.....	.....
Total	....	74	.....	.....	.....	.....	.....	.....	51	68.91
203d New York	A	61	27	44.26	17	27.85	44	72.13	.....	.....
	C	45	16	35.55	10	22.22	26	57.77	.....	.....
	K	48	19	39.58	12	25.00	31	64.58	.....	.....
Total	....	154	.....	.....	.....	.....	.....	.....	101	65.58
Grand total	....	228	92	40.35	60	26.31	.....	.....	152	66.66

General table showing average interval between connectable typhoid fever attacks in tents (as deduced from surgeons' tent lists) in three regiments of the Second Army Corps at Camp Meade, Pa.

Regiment.	Attacks plotted.	Intervals of directly connectable attacks in same tents.	Aggregate days between connectable attacks.	Average days between connectable attacks.	Intervals of indirectly connectable attacks in next tents.	Aggregate days between connectable attacks.	Average days between connectable attacks.	Regimental totals.	Aggregate days between connectable attacks.	Average days between connectable attacks.	Grand totals.		
											Number of intervals between connectable attacks.	Aggregate days between connectable attacks.	Average days between connectable attacks.
35th Michigan	189	33	334	10.1	45	442	9.8	78	776	9.9	.....	.....	.....
15th Minnesota	436	118	1,194	10.1	96	987	10.3	214	2,181	10.2	.....	.....	.....
203d New York	467	56	606	10.8	86	873	10.1	142	1,479	10.4	.....	.....	.....
Grand total	1,092	207	2,134	10.3	227	2,303	10.1	.....	.....	.....	434	4,436	10.2

Table showing average interval between typhoid attacks in tents (as deduced from captains' lists) in certain companies of two regiments of the Second Army Corps at Camp Meade, Pa.

Regiment.	Company.	Attacks plotted.	Direct (same tent) intervals of connectable typhoid attacks.	Aggregate days interval between connectable attacks.	Average days intervals between connectable attacks.	Indirect (next tent) intervals of connectable typhoid attacks.	Aggregate days interval between connectable attacks.	Average days intervals between connectable attacks.	Company totals (direct and indirect).			Regimental totals.		
									Number of intervals between connectable attacks.	Aggregate days interval between connectable attacks.	Average days intervals between connectable attacks.	Number of intervals between connectable attacks.	Aggregate days interval between connectable attacks.	Average days intervals between connectable attacks.
35th Michigan	A	45	14	149	10.6	15	143	9.5	29	292	10.0	------	------	------
	L	29	4	45	11.2	7	85	12.1	11	130	11.8	------	------	------
Total	----	74	------	------	------	------	------	------	------	------	------	40	422	10.5
203d New York	A	61	15	145	9.6	15	145	9.6	30	290	9.6	------	------	------
	C	45	10	121	12.1	8	89	11.1	18	210	11.6	------	------	------
	K	48	11	124	11.2	12	119	9.9	23	243	10.5	------	------	------
Total	----	154	------	------	------	------	------	------	------	------	------	71	743	10.4
Grand total	----	228	54	584	10.8	57	581	10.1	------	------	------	111	1,165	10.4

Table showing average interval between diarrheal and typhoidal attacks in same individual (as deduced from lists of diarrhea preceding typhoid), in eight regiments of the Second Army Corps, at Camp Meade, Pa.

Regiment.	Number of diarrheas preceding typhoid.	Aggregate days of interval between attacks.	Average days of interval between attacks.
3d Connecticut	4	41	10.2
5th Massachusetts	2	21	10.5
35th Michigan	11	122	11.0
15th Minnesota	26	306	11.7
201st New York	4	40	10.0
202d New York	1	12	12.0
203d New York	6	52	8.6
10th Ohio	12	153	12.7
Grand total	66	747	11.3

Table showing for the regiments of the Second Army Corps assembled at Camp Meade, Pa., the mortality and morbidity from typhoid fever.

Regiment.	Mean strength.	Cases of typhoid fever.		Deaths from typhoid fever.	Deaths from all diseases.
		Certain.	Certain and probable.		
FIRST DIVISION.					
1st Maryland	1,251	51	96	7	12
35th Michigan	1,150	269	385	21	25
10th Ohio	1,228	141	317	22	22
3d Connecticut	1,214	132	168	13	14
202d New York	1,125	110	195	10	11
15th Minnesota	1,280	415	475	18	18
Total	7,248	1,118	1,636	91	102
SECOND DIVISION.					
4th New York	1,225	6	13	0	0
20?d New York	1,047	371	503	16	18
2d West Virginia	1,165	112	219	15	17
5th Massachusetts	1,275	43	66	3	3
20?st New York	1,076	119	195	19	21
1st Delaware	926	30	58	6	7
Total	6,714	681	1,054	59	66
Total Second Corps	13,962	1,799	2,690	150	168
2d Pennsylvania	1,070	3	9	2	2

Regiment.	Deaths from typhoid fever in 100 cases—		Percentage of deaths from typhoid to deaths from all diseases.	Morbidity of typhoid fever per 1,000 mean strength—		Deaths from typhoid fever in 1,000 per mean strength.
	Certain typhoid.	Certain and probable.		For certain cases of typhoid.	For certain and probable cases of typhoid.	
FIRST DIVISION.						
1st Maryland	13.72	7.29	58.33	40.76	76.73	5.59
35th Michigan	7.80	5.45	84.00	233.91	334.78	18.26
10th Ohio	15.60	6.94	100.00	114.82	258.24	17.93
3d Connecticut	9.84	7.73	92.85	108.73	138.38	10.70
202d New York	9.09	5.12	90.90	97.77	173.33	8.88
15th Minnesota	4.33	3.78	100.00	324.21	371.09	14.06
Total	8.13	5.56	89.21	154.24	225.71	12.55
SECOND DIVISION.						
4th New York	0	0	0	4.89	10.61	0
20?d New York	4.31	3.18	88.88	354.30	480.42	15.28
2d West Virginia	13.39	6.84	88.23	96.13	187.97	12.87
5th Massachusetts	6.97	4.57	100.00	33.72	51.75	2.34
20?st New York	15.96	9.74	90.50	110.59	181.22	17.65
1st Delaware	20.00	10.34	85.71	32.39	62.63	6.46
Total	8.66	5.59	89.39	101.42	156.98	8.78
Total Second Corps	8.33	5.57	89.28	128.84	192.67	10.74
2d Pennsylvania	66.66	22.22	100.00	2.80	8.41	1.86

CHAPTER IX.

TYPHOID FEVER IN THE FOURTH ARMY CORPS.

Commands.—First Ohio, Third Pennsylvania, One hundred and fifty-seventh Indiana, Thirty-second Michigan, Second Georgia, Fifth Ohio, Fifth United States Cavalry.

It is impossible to follow, in the study of typhoid fever in this corps, the same methods adopted in our studies of the First and Third Army Corps. In the first place, the regiments of the Fourth Army Corps were frequently changed, some going to other organizations and others coming from other organizations. The Fourth Army Corps assembled near Mobile, Ala., at the place which we have designated as Camp Coppinger. While at this place six regiments (the First and Second Alabama, the First and Second Louisiana, and the First and Second Texas) were detached from this corps and sent to Miami, Fla., where these regiments constituted the First Division of the Seventh Army Corps. A study of the medical history of these regiments will be found in the history of the Seventh Corps. The regiments left at Mobile after the detachment of the six regiments mentioned above subsequently were moved to Tampa, Fla., and its vicinity. Here the Fourth Corps was recruited by regiments sent from Chickamauga and others sent from State encampments. The regiments sent from Chickamauga to the Fourth Army Corps at Tampa were the Second New York Volunteer Infantry, the Sixty-ninth New York Volunteer Infantry, the Fifth Maryland Volunteer Infantry, and the First Ohio Volunteer Cavalry. The history of typhoid fever in these regiments has already been discussed in connection with the First and Third Army Corps. Other regiments—the Third Pennsylvania Volunteer Infantry, the One hundred and fifty-seventh Indiana Volunteer Infantry, and the First Ohio Volunteer Infantry—stopped for a few days at Chickamauga Park on their way from State encampments to Tampa. Other regiments, such as the Fifth Ohio Volunteer Infantry, the Third Pennsylvania Volunteer Infantry, the Second Georgia Volunteer Infantry, the First Florida Volunteer Infantry, and the Thirty-second Michigan Volunteer Infantry, went directly from their State encampments to join the Fourth Army Corps at Tampa. It will be seen from the above that the histories of ten regiments (First and Second Alabama, First and Second Louisiana, First and Second Texas, Fifth Maryland Volunteer Infantry, Second New York Volunteer Infantry, Sixty-ninth New York Volunteer Infantry, and the First Ohio Volunteer Cavalry), at one time attached to the Fourth Army Corps, have already been given in connection with other organizations.

In the second place, the brigades of the Fourth Army Corps at Tampa were quite widely separated, and the conditions of the various

camps differed somewhat. One brigade (at that time the Third Brigade of the Second Division of the Fourth Army Corps), consisting of the First Ohio Volunteer Infantry, the One hundred and fifty-seventh Indiana Volunteer Infantry, and the Third Pennsylvania Volunteer Infantry, was encamped near Port Tampa City. The Second Brigade of the Second Division (consisting early in June, 1898, of the First District of Columbia Volunteer Infantry, Second New York Volunteer Infantry, and Fifth Maryland Volunteer Infantry) was encamped for a while in the vicinity of old Fort Brooke. Later in June the First District of Columbia Volunteer Infantry went to Cuba and became attached to the Fifth Army Corps. The Fifth Ohio Volunteer Infantry, the Third Ohio Volunteer Infantry, the Thirty-second Michigan Volunteer Infantry, the First Florida Volunteer Infantry, and the Second Georgia Volunteer Infantry were encamped in De Soto Park and along Palmetto Beach, immediately southeast of Tampa. The Fifth U. S. Cavalry, the Second U. S. Cavalry, and the First U. S. Volunteer Cavalry (until its departure for Cuba) were located immediately to the west of Tampa Bay Hotel. The Eleventh U. S. Infantry and the Nineteenth U. S. Infantry were located to the north of the city. There was also one brigade at Lakeland, Fla., some 30 miles distant from Tampa. In July the Nineteenth U. S. Infantry and the Eleventh U. S. Infantry were sent to Porto Rico.

During the latter part of July a part of the Fourth Army Corps was moved to Fernandina, Fla., and later (during the latter part of August) the whole of this corps was transferred to Huntsville, Ala.

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We will attempt to give the histories of only a few of the regiments of this corps. These will be sufficient to make us acquainted with the sanitary conditions of the camps occupied by this command. While we do not think that we have overestimated the number of cases of typhoid fever in these regiments, we desire to state that we can not be so positive on this point as we were concerning the regiments at Chickamauga, because, for the reasons to be stated later, we are convinced that malaria was much more prevalent among troops encamped about Tampa than it was in the First and Third Army Corps.

* * * * * * *

The conditions of the various camps occupied by this corps have been given in connection with the different regiments. It will be seen that while water contamination can not be excluded in the camps about Tampa, typhoid fever must have been disseminated by other agencies in the encampments at Fernandina and Huntsville. Typhoid infection appeared among the regular troops at Tampa before any of the volunteer regiments reached that place. The Second and Thirteenth U. S. Infantry furnished recognized cases of typhoid fever soon after reaching Tampa in May. The last-mentioned organi-

zation was stationed at Fort Niagara and Fort Porter, N. Y., when war was proclaimed, and it reached Tampa with one man sick with typhoid fever. So far as we have been able to ascertain this was the first case of this disease among the troops assembled at Tampa and in its vicinity in 1898. On June 7, 1898, the Fourth Corps reserve hospital was opened, and on this date it received 9 cases of recognized typhoid fever. Three of these were from the Thirteenth Infantry and one each from the Second, Fourth, Sixth, Sixteenth, Twenty-second, and Twenty-fourth Infantry, and before the last of June the following additional regular regiments sent cases of recognized typhoid fever to this hospital: Second and Fifth Cavalry and Third and Eleventh Infantry. It will thus be seen that many of the regular regiments entered upon the campaign already infected with typhoid fever. There is, therefore, no difficulty in accounting for the introduction of typhoid fever into the camps about Tampa, since many of both regular and volunteer regiments reached that place bringing with them the infection.

The following table shows at least approximate facts concerning typhoid fever in the regiments the histories of which we have just given:

Regiment.	Strength in July.	Total number of probable cases.	Percentage of troops with typhoid fever.	Number of recognized cases.	Total deaths.	Deaths due to typhoid fever.	Percentage of deaths among probable cases.	Percentage of deaths among recognized cases.
1st Ohio	1,085	221	20.36	27	10	9	4.07	33.33
157th Indiana	1,080	219	20.27	2	18	14	6.39	700.00
3d Pennsylvania	783	92?	11.74?	23	12	10	10.86	43.47
32d Michigan	1,239	253	20.41	34	20	19	7.50	55.88
2d Georgia	1,100	184	16.72	47	14	13	7.06	27.65
5th Ohio	1,320	310	23.48	88	22	20	6.45	22.72
5th U. S. Cavalry	960	219	24.33	219	16	14	6.39	6.39

Total strength for these regiments in July	7,507
Total number of probable cases of typhoid fever in these seven regiments	1,498
Percentage of probable cases of typhoid fever in these regiments	19.95
Number of recognized cases of typhoid fever in these regiments	440
Number of deaths due to typhoid fever in these regiments	99
Percentage of deaths among probable cases of typhoid fever	6.60
Percentage of deaths among recognized cases of typhoid fever	22.50

It will be seen from these figures that the percentage of deaths among probable cases of typhoid fever in these regiments is slightly lower than it was among the troops at Chickamauga, while the percentage of deaths among recognized cases is considerably higher.

We are quite confident that the number of cases of probable typhoid fever in the Third Pennsylvania Volunteer Infantry as given in the above table is much too low. On the other hand, it is possible that

we have overestimated the number of probable cases of typhoid fever in the First Ohio Volunteer Infantry.

We have elsewhere stated that we have reason for believing that malaria was more frequent among troops stationed at Tampa than it was among those encamped at Chickamauga. The board did not have opportunity to have blood examinations made among the troops of the Fourth Army Corps, and our reason for believing that malaria was more prevalent among those troops is founded upon information furnished us by Dr. G. W. Moorehouse, resident physician of the Lakeside Hospital, at Cleveland, Ohio. The Fifth Ohio Volunteer Infantry was from Cleveland, and when disbanded its sick were sent in part to this hospital. Here blood examinations were made by Dr. E. P. Carter. The malarial organism was found in 23 individuals from this regiment. In 5 of these cases malaria and typhoid fever were coincident.

We append a table showing for the regiments of the Fourth Army Corps the mortality and morbidity from typhoid fever.

Table showing for the regiments of the Fourth Army Corps (assembled at Mobile, Chickamauga, and Tampa) the mortality and morbidity from typhoid fever.

Regiment.	Mean strength.	Cases of typhoid fever.		Deaths from typhoid fever.	Deaths from all diseases.
		Certain.	Certain and probable.		
1st Ohio	1,085	27	221	9	10
157th Indiana	1,080	2	219	14	18
3d Pennsylvania	783	23	92	10	12
32d Michigan	1,239	34	253	19	20
2d Georgia	1,100	47	184	13	14
5th Ohio	1,320	88	310	20	22
5th U. S. Cavalry	900	219	219	14	16
Total	7,507	440	1,498	99	112

Regiment.	Deaths from typhoid fever in 100 cases of—		Percentage of deaths from typhoid to deaths from all diseases.	Morbidity of typhoid fever in 1,000 mean strength.		Deaths from typhoid fever in 1,000 of mean strength.
	Certain typhoid.	Certain and probable.		For certain cases of typhoid.	For certain and probable cases of typhoid.	
1st Ohio	33.33	4.07	99.00	24.88	203.68	8.25
157th Indiana		6.39	77.77	1.85	202.77	12.96
3d Pennsylvania	43.47	10.86	83.33	29.37	117.49	12.77
32d Michigan	55.88	7.50	95.00	27.44	204.19	15.33
2d Georgia	27.65	7.06	92.87	42.72	167.27	11.81
5th Ohio	22.72	6.45	90.90	66.66	234.84	15.15
5th U. S. Cavalry	6.39	6.39	87.50	243.33	243.33	15.55
Total	22.50	6.60	88.39	58.61	199.54	13.17

CHAPTER X.

TYPHOID FEVER IN OTHER ORGANIZATIONS AT CHICKAMAUGA.

Organizations.—Third U. S. Volunteer Cavalry, Cavalry Brigade, First Corps; First Illinois Volunteer Cavalry; First Ohio Volunteer Cavalry; Light Artillery Brigade, First Corps; Sixth U. S. Volunteer Infantry; Eighth U. S. Volunteer Infantry; hospital corps men, First and Third Army Corps; female nurses at Chickamauga.

TYPHOID FEVER AMONG HOSPITAL CORPS MEN IN THE FIRST AND THIRD ARMY CORPS.

We have been unable to obtain a statement of the strength of the hospital corps connected with the First and Third Army Corps. We find in the records of the various hospitals connected with the First and Third Army Corps 209 cases of recognized typhoid fever among the hospital corps men. At the time that we inspected the troops at Chickamauga Capt. H. B. Stotter was in command of the hospital corps. He stated that he had under his charge 110 men all told. The duties of these men consisted in acting as orderlies at Sternberg hospital and in policing the grounds. Captain Stotter had at that time been at Chickamauga for five weeks, but had had charge of the hospital corps for only three weeks. In fact, he was placed in charge a short time after the opening of Sternberg hospital. At the time of his taking charge of this corps all the men in it were on duty. At the time when he gave his testimony to us 36 were on the sick report; 16 of these were in the hospital. The prevailing diseases among the 20 in quarters were diarrhea and gastritis. Captain Stotter attributed the gastritis to the fact that these men drank too freely of infected milk. When we visited Sternberg hospital we found the hospital corps men drinking Chickamauga Creek water from the hydrants, although this water had been condemned. Captain Stotter attributed the diarrhea among his men to the use of this water. He reported that his men were fairly intelligent, amenable to discipline, and but little given to intoxication.

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It would be interesting if we could ascertain the total number of cases of typhoid fever among the hospital corps men, on account of the close contact these men had with typhoid patients. It was customary during a part of the time at Chickamauga, as it was at other national encampments, to detail men from the line to serve as orderlies in the hospitals. In some places these details were made daily; in others a detail was made for a week. At the expiration of the time for which the detail was made the men were returned to their respective regiments and other men for like purposes detailed at the hospital. This method of securing orderlies to care for patients

with typhoid fever or other infectious disease is to be condemned most emphatically. Undoubtedly this was one of the means by which typhoid fever was spread through the different organizations. Men wholly ignorant of methods of disinfection were assigned to the task of caring for patients and disinfecting stools. Many of these men undoubtedly infected themselves and went back to their regiments without even disinfecting their hands. At one hospital we found that the orderlies went to their respective messes in the different regiments without washing their hands.

CHAPTER XI.

TYPHOID FEVER IN THE FIRST AND SECOND DIVISIONS, SEVENTH ARMY CORPS.

GENERAL REMARKS ON THE FIRST DIVISION CAMP AT MIAMI, FLA.

The selection of Miami as a camp for troops gave occasion for much criticism, and it was the general belief of the medical officers of the Seventh Corps that the water supplied the troops at this place was contaminated and was the cause of the large amount of sickness in the division encamped there.

July 13 Lieutenant-Colonel Maus, chief medical officer of the Seventh Corps, went to Miami for the purpose of inspecting the camp. On his return to corps headquarters at Jacksonville he made a report to the Surgeon-General, from which the following quotations are taken:

The division at Miami consists of six regiments—First and Second Alabama, First and Second Texas, and First and Second Louisiana—and contains about 7,500 men. I was very much surprised to find such an unusually large percentage of sickness in this command. On the day of my arrival over 600 were on the sick report, besides almost that number suffering from various complaints but not on sick report. Many of this supplementary list were having dysentery and diarrhea, with from six to ten evacuations daily. The principal troubles consist of diarrhea and dysentery and malarial fevers, and there appears to be a universal opinion among officers and men that these diseases are due to the water supply. I made a careful inspection of the camp and found it otherwise in good sanitary condition. The regiments are located in piney groves adjacent to the city and on a coraline formation. The ground is not pleasant for camping purposes, because it is almost impossible to properly pitch the tents, and is very disagreeable for walking on, as it cuts the shoes and is disagreeable for the feet when they are bare. The night soil is disposed of by being deposited in troughs partly filled with water. These troughs are connected with the sewers and are emptied and flushed frequently, but in some regiments the night soil is deposited in tubs, which are carted away and emptied into the sea. Pits are used at some regimental headquarters. The contents of these are covered from day to day.

The water supply is from two sources. The city of Miami is supplied with

water taken from an open lake in the Everglades, about 4 miles distant. The water is piped to the city and distributed through the camp at convenient places. The other source is from driven wells which penetrate the coraline formation for a distance of from 18 to 21 feet. The water comes from the wells turbid and contains a large amount of suspended matter which deposits quickly on standing. It has a disagreeable taste and odor. I regard this water as unfit for use and believe it to be surface drainage. Many of the regimental officers have become so thoroughly convinced that this water is the chief cause of the prevailing illness that they have forbidden its use and have caused the handles to be removed from the pumps. The water from the Everglades is also turbid. It has a marshy taste and a decided odor. In my opinion, this water is probably productive of the malarial troubles. Thus, the soldier stands, as it were, between two dangers—the well water probably infected with typhoid, and the Everglade water, probably infected with the malarial poison. The Everglade water is much warmer, and consequently the soldier prefers that from the wells. The lake in the Everglades collects the drainage of an extended territory covered with tropical vegetation and is filled with tall grass.

The division hospital is located on a vacant lot in the center of the town. The tents are crowded. The ground is low and covered with brush and other vegetation. The lot has been partially cleared and some of the holes in it have been filled. One of these holes is about 30 feet in diameter and 6 feet deep. It seems to have been used as a deposit for rubbish. I expressed disapproval of this site, and had a board appointed to select a suitable one outside of the city.

On the day of my arrival the hospital contained 269 cases, many of which were mumps, measles, intestinal troubles, and continued fevers. Only 8 of these continued fevers were diagnosticated as typhoid, though they were continued and presented many of the symptoms of that disease, such as hebetude, iliac tenderness, gurgling, and, in some instances, rose-colored spots. These are unquestionably mild cases of typhoid fever. I believe that the Widal test should be made in all doubtful cases, and for this purpose I suggest that the hospital be supplied with pure cultures of the typhoid bacillus.

In a letter to the Adjutant-General, Colonel Maus makes the following additional statement concerning the water:

Major Archinard, who has taken an active interest in this matter, had forwarded before my arrival samples of water for analysis to Tulane University. The following telegram has been received from him:

"The chemist, Dr. Metz, says well water is contaminated with sewage. It contains large amounts of free and albuminoid ammonia, nitrates, and nitrites. Everglade water contains much vegetable matter. The bacteriologist, Dr. P. E. Archinard, states that a cursory examination shows both waters unfit for drinking purposes."

Colonel Wood, chief commissary of the Seventh Corps, under date of July 21, wrote concerning the water as follows:

To say nothing of the extremely high temperature of this water (the Everglade), owing to the direct action of the sun on the pipes, the water is about the color of that of the Missouri River and has a taste of vegetable matter that renders it unpleasant. To offset this, the troops have driven wells close to the company kitchens, and this water, while cooler, is daily contaminated by the slop and dishwater thrown on the ground to be pumped up again. To use either water seems to be the choice of two evils—malaria or typhoid fever—and I would earnestly recommend that the troops of the First Division be moved away from Miami, where the sick list is already amazingly large and daily increasing.

Colonel Guild, inspector-general of the Seventh Corps, writes of this water as follows, under date of July 19:

> The main water supply comes from the swamp known as the Everglades. Samples tried by me had an offensive odor. The men universally believe it to be infected. This water is distributed through pipes lying on the surface of the ground, and consequently it is hot and unpalatable. Thus the men are encouraged to drink the cooler but infected water of the driven wells.

A medical board was convened by Colonel Maus for the purpose of ascertaining the cause of the great sickness in this division. This board consisted of Major Peoples, of the Second Texas; Major Pugh, of the Second Alabama, and Captain Blanchard, of the First Louisiana. These gentlemen agreed that the water was infected. A second board, consisting of Major Archinard, of the Second Louisiana; Major Vilas, of the First Texas, and Lieutenant Jackson, of the First Alabama, was requested to determine the nature of the continued fevers prevalent in this camp. After making one post-mortem examination and having a large number of samples of blood submitted to the Widal test, they concluded, July 20, that there were 50 instead of only 8 cases of typhoid fever in the division hospital.

It seems to have been unquestionably demonstrated that the water first supplied through the pipes as Everglade water was in reality pumped from a large shallow well, the situation of which rendered its contents quite as likely to be infected as was the water from the regimental wells. After the discovery of this deceit the Everglade water was furnished.

THE FIRST DIVISION CAMP AT JACKSONVILLE.

This camp site, which was occupied on August 5, was located on ground bordering on the west bank of the St. Johns River, near the suburb of Fairfield. The general elevation of the site was about 15 feet above the river and admitted of fair, natural drainage, the ground sloping slightly from the river toward the shell roads. The soil consisted of sand which rapidly absorbed the rainfall. Shade trees were plentifully interspersed throughout the camp.

The water supply of this division was piped to the company streets from the deep artesian well of the Country Club at Fairfield.

For about two weeks after the arrival of the division from Miami, Fla., pits were dug along the shell road in rear of the regimental camp sites for the reception of excreta and garbage. At the date of our inspection, August 28, 1898, a system of water carriage for excreta had been already instituted for the regiments of this division. Boxes lined with zinc, having a capacity of 20 feet by 18 by 20 inches were provided. These were supplied with a constant stream of water, and at intervals of about one hour were emptied into the sewer and thoroughly flushed out. The sewer pipes discharged into the St. Johns River. Provision was made against overflow of these troughs.

At the time of our inspection, therefore, there was nothing objectionable, either in the matter of the water supply or in the disposal of the excreta of these regiments.

FIRST DIVISION OF THE SEVENTH ARMY CORPS.

At the time of our inspection, August 28 to September 5, 1898, this division consisted of the following regiments: First Alabama Infantry, Second Alabama Infantry, First Louisiana Infantry, Second Louisiana Infantry, First Texas Infantry, Second Texas Infantry, Fourth U. S. Volunteer Infantry, and First Ohio Infantry.

The two last-mentioned regiments, however, had been with this division only a few days, and it will be more satisfactory to consider the division as consisting of only six regiments, two from Alabama, two from Louisiana, and two from Texas.

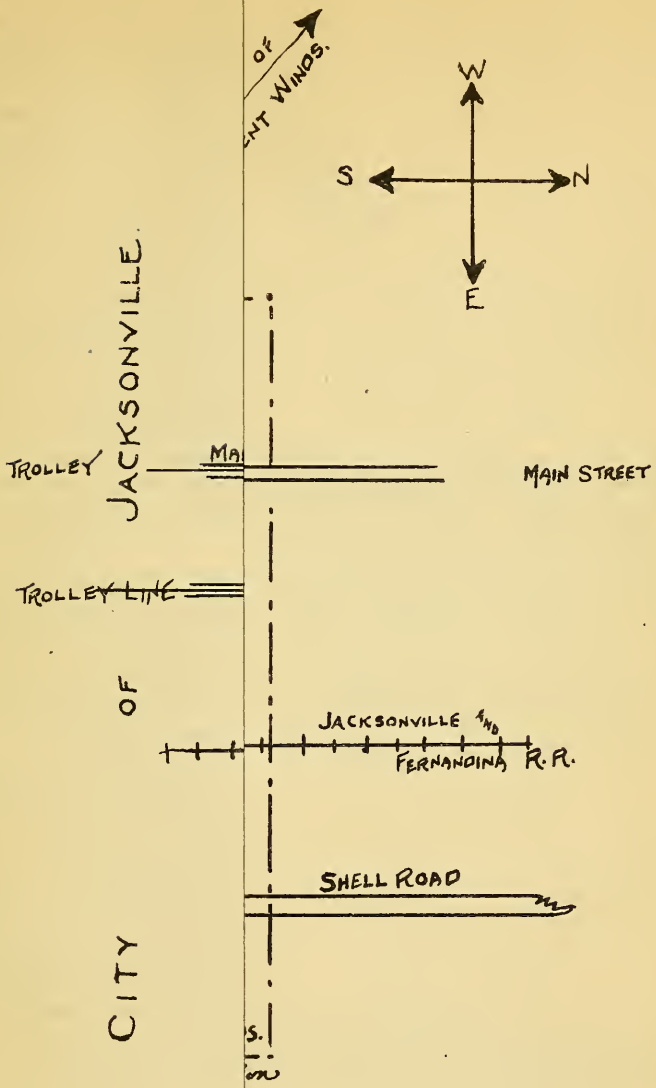
Table showing, for the regiments of the First Division of the Seventh Army Corps assembled at Jacksonville, Fla., the mortality and morbidity from typhoid fever.

Regiments.	Mean strength.	Certain and probable cases of typhoid fever.	Deaths from typhoid fever.	Deaths from all diseases.	Deaths from typhoid fever in 100 cases.	Percentage of deaths from typhoid to deaths from all diseases.	Morbidity of typhoid fever in 1,000 mean strength.	Deaths from typhoid fever in 1,000 mean strength.
1st Alabama	1,178	158	10	16	6.32	62.50	134.12	8.48
2d Alabama	1,079	159	8	16	5.03	50.00	147.35	7.41
1st Louisiana	1,224	269	11	16	4.08	68.75	219.77	8.98
2d Louisiana	1,102	177	8	15	4.51	53.33	160.61	7.25
1st Texas	1,105	111	8	13	7.20	69.23	100.45	7.23
2d Texas	1,164	156	8	15	5.12	53.33	134.02	6.87
Total	6,852	1,030	53	91	5.14	58.24	150.32	7.73

THE SECOND DIVISION CAMP AT JACKSONVILLE.

Commands.—Second New Jersey Infantry, Second Illinois Infantry, First North Carolina Infantry, Fiftieth Iowa Infantry, First Wisconsin Infantry, Second Virginia Infantry, Fourth Virginia Infantry, Forty-ninth Iowa Infantry, Ninth Illinois Infantry.

This site was within the city limits, being placed on a rather level strip of land situated between the extension of Main street and the Jacksonville and Fernandina Railroad. The sketch map which follows will show the location of the several regiments in their first encampment at Camp Cuba Libre. Later, when typhoid fever became quite prevalent in certain regiments, the Ninth Illinois, Fiftieth Iowa, and First Wisconsin were moved to a somewhat more elevated site about 1 mile west of this camp, but still within the city limits, while the Forty-ninth Iowa and the Second and Fourth Virginia were removed to a site near Long Branch, some 3 miles distant. The first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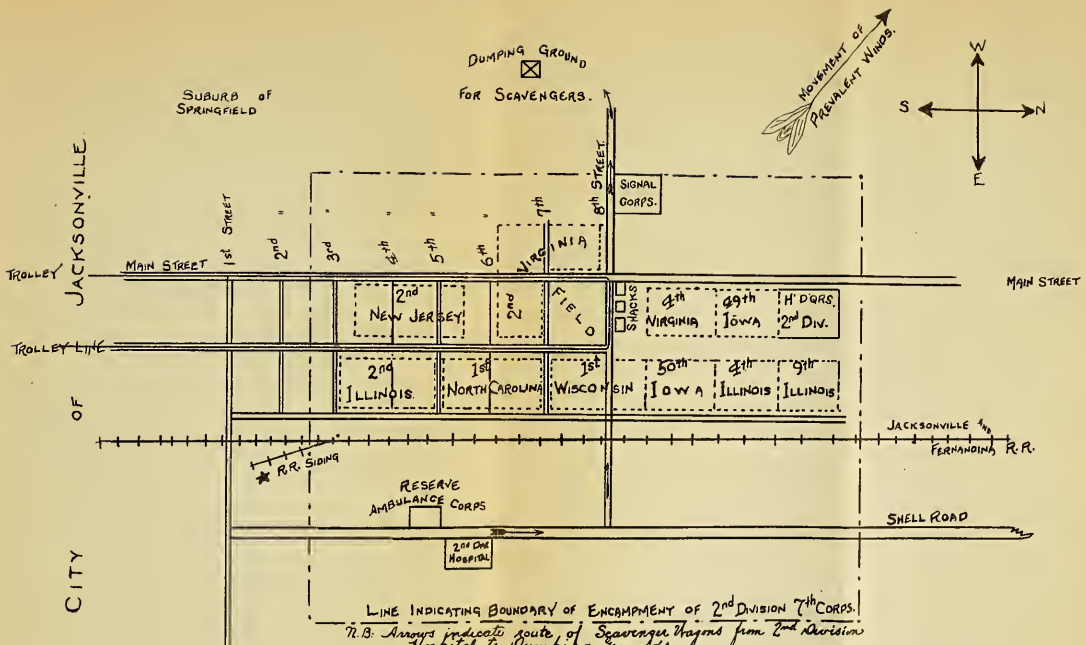

ROUGH PLOT
OF
FIRST ENCAMPMENT OF 2nd DIVISION, 7th CORPS,
AT
JACKSONVILLE, FLA.

SUBURB OF FAIRFIELD.

camp site of this division was not objectionable in dry weather, but when the rains began the location of the Forty-ninth and Fiftieth Iowa, Fourth Virginia and First Wisconsin became undesirable, owing to the lack of natural drainage and their proximity to the swampy ground. (See sketch map.)

The water supply was piped from the city supply to each company street, and was of excellent quality and very abundant.

Pits were dug for the reception of kitchen slops, but as the camp was within the city limits, pits for excreta were forbidden. For the disposal of excreta, therefore, half tubs were provided, which when partially filled were hauled away on wagons by the city authorities to a dumping ground, the tubs washed out by hose and returned for further use. As earth was not permitted to be used in these tubs, their condition was extremely filthy, the contents being unprotected from flies and frequently spilled out while being hauled away to the dumping ground. The location of the half tubs was in many instances in close proximity to the mess tents. (See regimental histories, Second Division.)

The amount of tentage was not sufficient for this division, the complaint having been repeatedly made to us that, in many regiments, eight men were sleeping in an A wall tent 9 by 9 feet. The division commander testified to the insufficiency of tentage.

In considering the development of typhoid fever in this division, then, we may say that four of the regiments imported the disease into the camp at Mobile, Ala., and that all of them acquired cases, few in number, at this camp; in just what way, it has been impossible for us to determine. We can state, however, that there does not appear to have been any contamination of the water supply. Transferred to Miami, Fla., during the third week in June, and placed in a camp which by unanimous testimony was undesirable, both as to the general character of the camp site and the water supply, typhoid fever, although occurring in increased numbers, did not reach that proportion of cases or that equal distribution in the command that should have resulted had the water supply been contaminated. To this we have repeatedly called attention in the histories of the several regiments.

It is important to observe that water carriage for the disposal of excreta was introduced into the camp at Miami, shortly after the arrival at that point, for the use of four of the six regiments, and that upon the transfer of the division to the camp at Jacksonville, Fla., the same method for the disposal of excreta was again made use of for all of these regiments. In this regard this division occupied an exceptional position at Jacksonville, and we shall later see that typhoid fever was far less prevalent in this division than in the Second and Third divisions of the Seventh Army Corps.

GENERAL DISCUSSION OF TYPHOID FEVER IN THE SECOND DIVISION, SEVENTH ARMY CORPS.

In briefly discussing the course of typhoid fever in the Second Division it is important to bear in mind that of the nine regiments originally constituting this division, four imported typhoid fever into this camp, viz: Second Illinois Infantry, First Wisconsin Infantry, Second Virginia Infantry, and Fourth Virginia Infantry. It is probable that the First North Carolina Infantry also imported the disease.

During the period from May 23, 1898, when these regiments began to arrive, until June 30, we observe that 77 cases of typhoid fever have occurred in this division in a strength of 10,759 men, or at the rate of 7.15 cases per 1,000 of mean strength. We further note that 58 of these cases occurred in regiments that imported the disease, and 13 additional cases in the First North Carolina Infantry, which we have reason to believe also imported typhoid fever. On the other hand, only six cases had occurred in the three regiments that did not import typhoid fever.

By reference to the graphic charts for this division, however, it will be plainly seen that while all regiments had cases of typhoid fever by June 30, the disease affected only certain companies in different regiments. Thus, in the Second Illinois seven companies had no cases of typhoid fever, in the Fiftieth Iowa nine companies had no cases, in the First North Carolina three companies had none, in the Second Virginia three companies had none. As all the companies of the several regiments had the same water supply, it is impossible to look to a contamination of the water as the source of infection.

The infection having been established in all regiments by June 30, we find that during the next fifteen days the cases have risen to 110, or at the rate of 10.2 cases per 1,000 of mean strength. This rate steadily rises for the period July 16 to 31, there having occurred 197 cases, or at the rate of 18.3 per 1,000 men, thus giving for the month of July 28.53 cases per 1,000 men, as against a rate of 7.24 for June.

The worst infected regiment in this division during July was the First Wisconsin Infantry, which had 89 cases; the least infected regiment, with 11 cases, was the Forty-ninth Iowa. Regiments whose camp sites and general surroundings appeared to be the same, except that the dust from the shell road, along which the scavenger wagons passed, was supposed to have been concerned in spreading infection among the men of the former regiments.

We have already, in a careful examination of this question (see history of the First Wisconsin), shown that however natural and plausible this theory of dust infection may have appeared, the facts do not substantiate it. While it is possible that isolated cases were due to this mode of infection, it can not be assigned as the chief cause.

During the month of August we find a steady increase in the num-

ber of cases of typhoid fever, all regiments except the First North Carolina showing an increase of cases, although unequal, so that for this month 858 cases are recorded. The rate per 1,000 men has, therefore, risen from 28.53 for July to 79.74 for August. We again call attention to the graphic charts which show that the disease was manifested by a series of company epidemics which varied much in their time of commencement, their course, and time of ending.

On August 1 two regiments, viz, the First Wisconsin and Fiftieth Iowa, were removed from their infected camp sites and placed upon higher ground about 1 mile west of their former camp. On August 14 the Second and Fourth Virginia and the Forty-ninth Iowa were also moved to a camp near the St. Johns River, about 3 miles northeast from the first site. We have been unable to observe that any reduction of cases of fever resulted from this move. On the contrary, we find a marked increase of cases in the First Wisconsin, Fiftieth and Forty-ninth Iowa, and no reduction in cases in the two Virginia regiments. Since each of these carried along with them many men already infected, together with infected clothing and bedding, the result is just what we should have been led to expect.

On August 8 the Ninth Illinois Infantry arrived from its State camp at Springfield, Ill., and was placed near the Fiftieth Iowa, 1 mile west of the old camp. This regiment imported typhoid fever, and had prior to the end of August 22 cases of this disease in its Florida camp. Like the other regiments of this division, it was provided with half tubs for the disposal of excreta.

The beginning of September (the fourth month of the Jacksonville encampment) found the regiments of the Second Division occupying three distinct camps, as follows: The original camp site by the Second Illinois, First North Carolina, and the Second New Jersey, forming the First Brigade; the Second Brigade, consisting of the First Wisconsin, Fiftieth Iowa, and Ninth Illinois, located 1 mile west of the old camp; and the Third Brigade, consisting of the Second and Fourth Virginia and Forty-ninth Iowa, occupying a new site 3 miles northeast of the old camp. Of the regiments which continued to occupy these camp sites during September, typhoid fever increased steadily in all. Three regiments were moved during the month, viz: Second New Jersey to Pablo Beach on September 2; First Wisconsin to its State encampment on September 7; and the Fiftieth Iowa also to its State encampment on September 17. In all of these regiments there is an apparent great reduction in cases of typhoid fever following their respective moves; but this is due in the cases of the First Wisconsin and Fiftieth Iowa to absence of any records after the date of their departure. In the case of the Second New Jersey there was a reduction in cases from 156 for August to 106 for September, and this reduction may be real, as the regiment was occupying a salubrious site on the beach at Pablo, Fla., during the entire month of September. To the defectiveness of the records from the Pablo Beach Hospital was

probably partly due this decrease in cases of typhoid fever. In calculating the progress of typhoid fever for the month of September we therefore only include those regiments which were not subjected to any movement during the month. We thus find in a mean strength of 7,222 men 733 cases of typhoid fever, or a rate of 100.15 cases per 1,000 of strength, as compared with 79.74 per 1,000 for August. Looking at the charts of the individual regiments, we find that all show a marked increase of cases, except the Second Virginia, in which there are recorded the same number of cases for September as for August, but there are no records of this regiment for the last days of September. The largest increase occurred in the Forty-ninth Iowa—295 cases as against 117 for August. When we recall that this regiment had been given a new camp site on August 14, and that its method of disposal of excreta had been changed from the very objectionable and much criticised "tub system" to that of dug pits, and that each soldier was required to cover his stool immediately, under the eye of a sentinel, we are inclined to admit that there must be other means concerned in the propagation of typhoid fever in military camps than the transference of the specific bacillus by flies. The infection which had taken such a hold on this regiment was still manifested by the occurrence of 133 cases during October, the first 25 days of which were spent in the same camp. By reference to the graphic chart it will be seen that the course of the disease was characterized by company epidemics, and that while Companies E, K, and L had but 1, 3, and 5 cases, respectively, other companies were much afflicted. In the Ninth Illinois Infantry, typhoid fever continued to prevail during October, there being recorded 82 cases against 101 for September. The same remark may be applied to the Second Illinois, the First North Carolina, and the Fourth Virginia, the only remaining regiments of the Second Division at Camp Cuba Libre, although there was a marked reduction in the number of cases.

During the last week in October, 1898, the Second Division was transferred to Savannah, Ga. (For details of the later occurrence of typhoid fever, see regimental histories.)

Table showing for the regiments of the Second Division of the Seventh Army Corps, assembled at Jacksonville, Fla., the mortality and morbidity from typhoid fever.

Regiments.	Mean strength.	Cases of typhoid fever.		Deaths from typhoid fever.	Deaths from all diseases.
		Certain.	Certain and probable.		
2d Illinois	1,095	253	341	18	22
1st North Carolina	1,164	147	227	16	20
2d New Jersey	1,153	185	318	29	32
1st Wisconsin	1,232	209	311	46	48
50th Iowa	1,097	164	253	33	33
9th Illinois	1,288	153	248	18	28
2d Virginia	1,220	105	152	17	20
4th Virginia	1,274	135	231	21	28
49th Iowa	1,236	378	612	50	50
Total	10,759	1,729	2,693	248	281

Table showing for the regiments of the Second Division of the Seventh Army Corps, etc., the mortality and morbidity from typhoid fever—Continued.

Regiments.	Deaths from fever in 100 cases of—		Percentage of deaths from typhoid to deaths from all diseases.	Morbidity of typhoid fever in 1,000 mean strength.		Deaths from typhoid fever in 1,000 mean strength.
	Certain typhoid.	Certain and probable.		For certain cases of typhoid.	For certain and probable cases of typhoid.	
2d Illinois	7.11	5.27	81.81	231.05	311.41	16.43
1st North Carolina	10.88	7.04	80.00	126.28	195.01	13.74
2d New Jersey	15.67	9.11	90.62	160.45	275.80	25.15
1st Wisconsin	22.00	14.79	95.83	169.64	253.43	37.33
50th Iowa	20.12	13.04	100.00	149.49	230.62	30.08
9th Illinois	11.76	7.25	64.28	118.80	192.54	13.97
2d Virginia	16.19	11.18	85.00	86.06	124.59	13.93
4th Virginia	15.55	9.09	75.00	105.96	181.31	16.48
49th Iowa	13.22	8.16	100.00	305.82	495.14	40.49
Total	14.34	9.20	88.25	160.70	250.30	23.05

CHAPTER XII.

TYPHOID FEVER IN THE THIRD DIVISION, SEVENTH ARMY CORPS.

Commands.—Second Mississippi Infantry, Fourth Illinois Infantry, First South Carolina Infantry, Second U. S. Volunteer Cavalry, Third Nebraska Infantry, One hundred and sixty-first Indiana Infantry, Sixth Missouri Infantry, Second South Carolina Infantry.

THE THIRD DIVISION CAMP AT JACKSONVILLE, FLA.

This division was encamped at Panama Park, about 4 miles northeast of Jacksonville. The ground selected for the camp was elevated and rolling, thus admitting of good natural drainage.

The water supply was obtained from a deep artesian well (800 feet) at Panama Park, and was piped under constant pressure to every company street. Its quality was therefore unexceptionable.

For the disposal of garbage and excreta pits were dug in the sandy soil to a depth of about 6 feet. The contents were covered with earth and lime about three times daily. During the latter part of the encampment each soldier was required to cover his stool immediately with dry earth, under the supervision of a sentinel stationed at the sink.

The regimental histories which follow must be consulted for the location of sinks, which differed much in distance from the mess tents in different regiments. In the case of the Second Mississippi, Third Nebraska, and One hundred and sixty-first Indiana these pits were dangerously close to the kitchens and mess tents.

As regards general location this camp was preferable to that occupied by the Second Division.

GENERAL PROGRESS OF TYPHOID FEVER IN THE THIRD DIVISION.

We have so fully reviewed, in connection with each regiment's history, the course of typhoid fever that little remains to be said concerning the progress of the disease. We observe in this division that seven of the eight regiments imported cases of typhoid fever into their camp at Panama Park. The first regiment to arrive at this camp was the Second Mississippi Infantry (June 21), which imported 9 cases from its camp at Jackson, Miss. The Second U. S. Volunteer Cavalry, arriving June 28, did not import typhoid fever. With this exception, however, the remaining regiments, which came in July, August, and September, all brought cases of the disease. It is not necessary, therefore, to look to other sources for the origin of typhoid fever in this division. Indeed, the opportunity for infection outside of the camp was very slight. Once imported, the course of the disease in the individual regiments did not differ from its progress in other divisions of this corps, or in the First, Second, Third, or Fourth Corps, heretofore treated of. With few cases during the first month after its introduction, its progress was, as a rule, steady during the second and third months, being marked by company epidemics of greater or less severity. We note that in the case of the First South Carolina Infantry, which joined this division on July 30, 1898, typhoid fever made but slight progress, although the conditions for the propagation of the disease appeared not to differ from those by which all other regiments of this division were surrounded. We have been unable to offer any explanation for this partial freedom from typhoid fever in this regiment.

There was nothing in the course of the disease in any of the regiments that indicated any contamination of the regimental or company water supply.

Table showing for the regiments of the Third Division of the Seventh Army Corps, assembled at Jacksonville, Fla., the mortality and morbidity from typhoid fever.

Regiments.	Mean strength.	Certain and probable cases of typhoid fever.	Deaths from typhoid fever.	Deaths from all diseases.	Deaths from typhoid fever in 100 cases.	Percentage of deaths from typhoid fever to deaths from all diseases.	Morbidity of typhoid fever in 1,000 mean strength.	Deaths from typhoid fever in 1,000 mean strength.
4th Illinois	1,194	238	20	25	8.40	80.00	199.32	16.75
161st Indiana	1,304	134	14	15	10.44	93.33	102.76	10.73
2d Mississippi	1,217	118	17	22	14.40	77.27	96.95	13.96
6th Missouri	1,149	286	19	22	6.64	86.36	248.91	16.53
3d Nebraska	1,262	280	27	30	9.64	90.00	221.87	21.39
2d South Carolina	945	85	8	14	9.41	57.14	89.94	8.46
2d Volunteer Cavalry	919	151	15	18	9.93	83.33	164.30	16.32
Total	7,990	1,292	120	146	9.28	82.19	161.70	15.01

MALARIAL DISEASES IN THE SEVENTH ARMY CORPS.

At the request of this board Dr. James Carroll, acting assistant surgeon, U. S. Army, was sent to Camp Cuba Libre for the purpose of determining, by blood examinations, whether malarial diseases were as prevalent as the diagnosis of regimental and division hospital medical officers would indicate. The following report is submitted entire:

WASHINGTON, D. C., *September 19, 1898.*

SIR: I have the honor to submit the following report of work done at Camp Cuba Libre, Jacksonville, Fla., under paragraph 32, Special Orders, No. 206, Adjutant-General's Office, September 4, 1898, and instructions received personally from you.

I reported at the Second Division hospital on the afternoon of September 5, and on the next morning drew blood from 16 patients for the purpose of applying the Widal test as the first step in determining the nature of the fevers prevailing there. Brief notes were taken of the dates of admission, history, and prominent features in each case. Of the 16 specimens taken, 14 gave a positive reaction next day; 1 was negative, but suspicious, from the fact that motility was impaired and a small number of the bacilli showed a tendency to agglutinate; and 1 was entirely negative. The case from which the latter was taken had only been admitted to the hospital on the preceding day, with an evening temperature of 104° and a previous history of epistaxis.

September 8 I drew blood from 45 patients in another ward, making no selections and taking them in regular order. Three of these were thought by the physician in charge of them to be probable cases of malarial fever. One was supposed to have had a frank chill, with a regular ague shake every other day since his admission, September 1. He had been sick in quarters seven days previously, and his tongue presented the appearance of that of a typhoid-fever patient. Another, admitted to hospital August 17, had been sick in quarters two weeks. The third had been sick nearly two months, three weeks of that time in quarters, doing light duty. He was taken sick on the second or third day after he arrived in camp, with malaise and fever, with sweating, but had never had a chill. Examinations of the fresh blood for malarial parasites in these cases were negative, but all 3 reacted positively to the Widal test. Of the 45 samples of blood taken, 39 gave a positive reaction, 3 gave a reaction that was incomplete, and 3 negative. Those noted at the time as incomplete gave what appeared to be a positive reaction next morning. Of the 3 negative specimens, 1 showed a positive reaction, with distinct clumping, next morning; the other 2 remained unchanged. One of these negative cases gave a positive reaction with a second specimen drawn September 16, the other still remaining negative, so that out of 45 consecutive cases only 1 remained absolutely negative.

My attention was next directed to the receiving ward of this hospital, from whence the patients were distributed, in the hope of securing malarial cases immediately upon admission, but only a few promising ones could be found. One man of the reserve ambulance company was doing duty with an evening temperature of 103° and morning temperature of 100°. He had a large, pale, furred tongue, and gave a history of malaise for about two weeks. Examinations for malarial parasites, negative; widal test, negative. Another case, examined September 12, was admitted to hospital September 11 with an evening temperature of 104° and morning temperature of 102°. Quinine had been withheld and an examination was requested for malarial infection. History: Sick in quarters six days; feeling badly nine days before going on sick report. His tongue is

slightly coated and quite red at the tip and edges. Examination for malaria, negative; widal test, negative. Still another, a lieutenant, who continued to perform his duties, complains of headache and soreness of the bowels for several days, with anorexia. He had no chill; his tongue is moist and furred, edges slightly reddened. Quinine had been withheld and an examination of his blood for malarial parasites requested. Result, negative; Widal test, negative. When I left the camp, four days later, I was told that his condition was about the same, and appendicitis was suspected. I believe he was in the prodromal stage of typhoid fever.

I was next called to a supposed case of tertian intermittent fever from which quinine was said to have been withheld. He gave a history of having been sick ten days or two weeks before his admission to sick report two days ago. He had had chilly sensations, followed by fever and sweating, at irregular intervals. Took quinine when he was first feeling badly, and is now taking gr. v every 4 hours. Examinations for malaria, negative; Widal test, positive.

I was shown a case of considerable interest on September 11. Private A. G., Company K, Forty-ninth Iowa Infantry, admitted to hospital September 7, had been sick in quarters one week. History of headache, pains in the back, and epistaxis occurring several times. Pulse very slow, about 50 to 60. There is much depression, a slight mental hebetude, and he has vomited blood several times. There are no signs of jaundice. Examinations of fresh blood for malarial parasites, negative. Widal test gives prompt arrest of motility and slight agglutination at the end of an hour. I ought to have stated that his temperature was subnormal and there was a constant hiccough. Patient died at 9 a. m. September 13, and at the autopsy, which I witnessed, there were found thickened, injected, and ulcerated Peyer's patches in the ileum and appendix; swollen glands in the mesentery and meso-appendix; moderate splenic tumor; liver but little changed from normal. The mucous membrane of the stomach was intensely injected, and the organ contained a thin, dark, bloody fluid; the intestine also contained a tarry material. Very marked changes were apparent in the kidneys, which appeared to be the seat of an acute parenchymatous nephritis. Both were enormously swollen, soft, and their surfaces were dotted with enlarged stellate veins. The cortex of each was very much increased in thickness, grayish, cloudy, and marked with dark-red pin-head spots (Malphigian bodies) over the cut surface. The pyramids were darkly congested. His urine was said to have shown about one-third of its volume of albumen.

The receiving ward proving very unfruitful in producing cases of malaria, I deemed it best to apply the Widal test in conjunction with an examination of the fresh blood for malarial parasites, where there seemed to be the slightest indication for it, to a series of cases in any one of the general wards, all of which were practically filled with patients suffering from fever of a remittent or continued type. At the same time I made it known that I was ready and anxious to examine the blood of any patient known or suspected to be suffering from malarial infection. These examinations, with the results, are shown in tabulated form in Appendix A.

On September 12 I visited the hospital of the Third Division, Seventh Army Corps.

The first ward studied was under the charge of a contract surgeon from Indiana, who had been so much impressed by the assertions of the local physicians as to the prevalence of malarial disease that he regarded all of his cases as malarial and treated them without discrimination as such. No temperature charts or records of the histories of the cases were kept by him, and he had no data to offer beyond the date of admission to hospital. Upon eliciting histories from the patients in his presence, and pointing out the rose spots and other diagnostic signs of typhoid fever, he admitted that some of the cases "might be typhoid fever, but was con-

fident there was a strong malarial element in all of them." To eliminate this he was administering to all classes of patients, both mild and severe, dr. iv of Warburg's tincture every 4 hours.

The cases in this ward were so clearly typhoid fever, and not malarial, that fresh blood examinations were not made, and drops were taken for the Widal test only from 7 of the least typical ones. For the results, see cases 1–7, Appendix B.

The next ward visited was under the charge of a volunteer medical officer. He was in doubt about the diagnosis of many of his patients, but was confident many of them were malarial. He was preparing carefully written histories and temperature charts of all his cases. He volunteered the statement, however, that nearly every one of his fever patients had been bitten by some unknown insect, but the bites, he said, were not at all like the rose spots of typhoid fever. He could not name or describe the insect, nor could he explain why the so-called "bites" appeared only upon the trunk, and seldom or never upon the extremities. Examination disclosed the characteristic roseola, and the histories and symptoms of the patients all pointed to typhoid fever, in mild as well as severe forms. Examination of blood in nearly all of these cases was clearly not called for, so plainly were the diagnoses established by the clinical examination. Drops of blood were taken from a few (6) of the least typical cases at the surgeon's request. Three of them were doubtful cases, and the others were supposed to be cases of malarial fever. I drew blood from only 13 patients at this division hospital, applying the Widal test to all of them, and in 2 instances the fresh blood was examined for malarial parasites with negative result. Of the 13 tests for the typhoid reaction, 12 proved positive and only 1 negative, and the patient from whom the negative specimen was procured showed the unmistakable roseola.

The third ward visited was in charge of a contract surgeon with a foreign accent, but who had received his medical education in the United States. I asked him if his ward contained any cases of malarial fever, to which question he replied very promptly and with emphasis, "Not one." Upon further interrogation he stated that of the 50 patients under his control 46 were typhoid fever and 4, as yet, undetermined. His cases differed not at all from those in the adjoining wards, and it was truly refreshing to meet such a man whose confidence showed that he spoke from firm conviction.

On September 13 I visited the Third Division hospital, Surgeon Munday temporarily in charge. I inquired for any cases of malarial fever, but none could be found, though I heard the diagnosis, "Malarial remittent fever, mild form," called several times in the office by men who appeared to be comparing monthly reports of sick and wounded. I was told that the cases were chiefly typhoid fever, dysentery, and diarrhea. I was taken to 1 patient whose diagnosis was regarded as doubtful, probably a case of malarial fever:

F. O., Company A, First Alabama, admitted to hospital September 7, sick for about eight days previously. There were several small rose spots, disappearing on light pressure, over the chest and abdomen. It was supposed that a segmenting malarial parasite (vacuolated leucocyte?) had been seen in the patient's blood that morning. I did not think it necessary to examine the fresh blood for malarial parasites but obtained a drop or two for the Widal reaction. Tested next morning it gave a positive reaction. This was the only case of continued or remittent fever, so far as I could learn, that was not recognized as typhoid fever.

Three cases of supposed malarial fever were brought into the hospital from one of the regiments during my visit. They were cases recently admitted to sick report and had not as yet been treated in bed.

1. C. D., Company F, First Texas. Has been ailing for about a month. He had diarrhea for some time. He had a chill yesterday and had taken no quinine since the chill. Examination for malarial parasite, negative; Widal test, negative.

2. G. R., Company D, First Texas. Sick about two and one-half days. Has

had no chill, but has felt badly for two days before going on sick report. Took quinine gr. vi to-day at 1 p. m. Examination for malarial parasite, negative; Widal test, negative.

3. R. W, Company F, First Texas. Has been sick a day and a half. Has had only fever; no chill and no sweating. Has not taken any quinine. Examination for malarial parasite, negative; Widal test, positive.

It is remarkable that 1 case in 3 gave a positive reaction so early in the disease, and it recalls 3 similar supposed cases of malaria which were all the cases of fever I could find at the camp of the Twelfth Pennsylvania Infantry at Camp Alger. They were all sick in quarters only, and were believed to be convalescent from mild attacks of malarial fevers. I transcribe verbatim from my notes made at the time.

CAMP ALGER, *August 24, 1898.*

1. W. A. G., Company E, Twelfth Pennsylvania. Chilly sensations followed by fever is the only history. Examination for malarial parasites, made at once, negative. August 25, 1898, Widal test, positive; good reaction.

"2. H. C. R., Company E, Twelfth Pennsylvania. Has had a number of frank chills, followed by fever and sweating. This was the history given by the man himself, who said he had had regular ague shakes. Examination for malarial parasites, made at once, negative. August 25, 1898, Widal test, positive reaction, typical.

"3. H. W. S., Company E. Twelfth Pennsylvania. Gives a history of chilly sensations followed by malaise and a mild fever. Examination for malarial parasites, made at once, negative. August 25, 1898, Widal test, negative."

It is worthy of note that in a camp of a whole regiment the 3 cases came from the same company.

To return to camp Cuba Libre. Having been told by the chief surgeon of the Third Division hospital that a considerable number of cases of malarial fever had been reported by the medical officers of the Second U. S. Volunteer Cavalry, I made a special trip to the camp of that regiment, September 14, for the purpose of examining any cases of malaria that could be found. I saw the junior medical officer, who stated that he had sent a patient to hospital an hour previously who, he was certain, was a case of malarial fever, and to whom quinine had not been administered. Besides this patient the captain (medical officer) showed me another patient diagnosed malarial fever, and these were all that he had of that class of cases.

1. E. J., Troop H, Second Volunteer Cavalry, just admitted to hospital. Has been feeling badly for two weeks. Gives a history of pains in back and limbs, diarrhea, soreness of bowels. His tongue is coated, and the edges are bright red. Roseola is present. Widal test, negative.

2. N. E. D., Troop L, Second Volunteer Cavalry, admitted to hospital September 13; to quarters September 10. History of headache, insomnia. Tongue coated and with bright-red edges. Examination for malarial parasites, negative; Widal test, negative.

Failure to obtain a positive reaction with the typhoid bacillus early in the disease is no evidence that the patient is not suffering from typhoid fever. On the other hand, a failure to find any of the parasites of malaria, with the absence of pigmented leucocytes, is positive evidence that the patient is not suffering from malarial infection at the time the examination is made. The uniformity of the results obtained in this work has been a revelation to me, and I am more than ever impressed with the great value of the Widal test in clearing up the diagnosis in doubtful and especially in atypical cases of typhoid fever, provided, of course, the test be not applied too early in the course of the disease. I have been impressed also by the fact that cases, apparently those of malarial fever, and in which I

expected to find the parasites, were absolutely negative in that regard, and gave a positive reaction for typhoid fever. I regard the fact as conclusively proven, by the reports hereto appended, that the fever prevailing among the troops at Camp Cuba Libre was typhoid fever, pure and simple. Many of the cases were ambulatory ones, in others the fever was of an ephemeral type. I do not make the statement that isolated cases of malaria did not exist at the time of my visit, but I am positive in the assertion that no single case of continued or remittent fever that came under my observation was due to malarial infection, for with the means at hand of making an absolutely certain diagnosis, by examination of the fresh blood, I failed to discover a single parasite.

I invited Capt. George P. Peed, assistant surgeon, Fourth Virginia Infantry, who is a graduate of the University of Virginia and a post-graduate student of the medical department of the Johns Hopkins University, to accompany me in my visits to the First and Third Division hospitals, and he can bear me out in any of the general or specific statements made herein. As he was made familiar with the practical application of the Widal test, and observed a number of my preparations under the microscope, he can also testify in a general way to the constancy with which a positive result was obtained.

I was accorded every facility for the prosecution of my work by the surgeon in charge of the Second Division hospital, who placed a hospital tent with tables and other conveniences at my disposal.

Very respectfully, your obedient servant,

JAMES CARROLL,
Acting Assistant Surgeon, U. S. Army.

Maj. WALTER REED,
Surgeon, U. S. Army.

In this connection we have endeavored to trace the protective influence which such supposed malarial fevers would confer upon the enlisted men of the Second and Third divisions of this corps. The following tables will give the result of our investigations:

Cases of typhoid fever among men with and without preceding malarial diseases in the Second Division, Seventh Army Corps, at Jacksonville, Fla.

Regiments.	Mean strength.	Cases of malaria.	Cases of malaria followed by typhoid fever.		Number of men without preceding malaria.	Typhoid cases without preceding malaria.		Total cases of typhoid fever.
			Number of cases.	In 100 malarial cases.		Number of cases.	In 100 men who have not had malaria.	
2d Illinois	1,095	162	9	5.5	933	272	29.20	281
9th Illinois	1,288	217	11	5.1	1,071	189	17.60	200
49th Iowa	1,236	235	11	4.7	1,001	461	46.05	472
50th Iowa	1,097	149	2	1.7	948	194	20.50	196
2d New Jersey	1,153	216	13	6.0	937	230	24.50	243
1st North Carolina	1,164	120	5	4.2	1,044	190	18.20	195
2d Virginia	1,220	109	1	.9	1,111	120	10.80	121
4th Virginia	1,274	308	21	6.8	966	151	15.60	172
1st Wisconsin	1,232	160	8	5.0	1,072	237	22.10	245
Totals	10,759	1,676	81	4.8	9,083	2,044	22.50	2,125

That is, of 1,676 individuals who have been treated for malarial fever 81, or 4.8 per cent, subsequently had typhoid fever.

Of 9,083 individuals who had not been treated for malarial fever 2,044, or 22.5 per cent, had typhoid fever.

Or, of 2,125 cases of typhoid fever 81, or 3.3 per cent, had previously been treated for malarial fever.

Of 2,125 cases of typhoid fever 2,044, or 96.7 per cent, had not been treated for malarial fever.

Cases of typhoid fever among men with or without preceding malarial diseases for seven regiments of the Third Division, Seventh Army Corps, at Jacksonville, Fla.

Regiments.	Mean strength.	Cases of malarial fevers.	Typhoid fevers preceded by malaria.		Number of men without malarial diseases.	Typhoid fever without preceding malaria.		Total cases of typhoid fever.
			Number of cases.	In 100 men with preceding malaria.		Number of cases.	In individuals without malaria.	
4th Illinois	1,194	200	3	1.5	994	235	23.6	238
161st Indiana	1,304	299	7	2.3	1,005	127	12.6	134
2d Mississippi	1,217	614	10	1.6	603	108	17.9	118
6th Missouri	1,149	176	7	3.9	973	279	28.6	286
3d Nebraska	1,262	307	6	1.9	955	274	28.6	280
2d South Carolina	945	537	6	1.1	408	79	19.3	85
2d Volunteer Cavalry	919	233	7	3.0	686	144	20.9	151
Total	7,990	2,366	46	1.9	5,624	1,246	22.1	1,292

That is, of 2,366 individuals who had been treated for malarial fever 46, or 1.9 per cent, subsequently had typhoid fever.
Of 5,624 individuals who had not been treated for malarial fever 1,246, or 22.1 per cent, had typhoid fever.
Or, of 1,292 cases of typhoid fever 46, or 3.5 per cent, had previously been treated for malarial fever.
Of 1,292 cases of typhoid fever 1,246, or 96.5 per cent, had not been treated for malarial fever.

Combining the above tables for the Second and Third divisions, we see that of 4,042 individuals who had been treated for these supposed malarial fevers, only 127, or 3.1 per cent, subsequently had typhoid fever; whereas of 14,687 soldiers who had not experienced these milder fevers not less than 3,290, or 22.4 per cent, afterwards contracted typhoid fever.

These tables, taken in connection with Dr. Carroll's careful observations, serve to indicate the slight part played by malaria in the causation of fevers at Camp Cuba Libre.

RELATION OF INTESTINAL DISORDERS TO TYPHOID FEVER.

Our investigations on this point agree with the results obtained in our study of the regiments of the Second Army Corps, as shown in the following tables:

Cases of typhoid fever among men with and without preceding diarrheal diseases in the Second Division, Seventh Army Corps, at Jacksonville, Fla.

Regiments.	Mean strength.	Cases of diarrheal disease.		Cases of diarrhea followed by typhoid.		Number of men without preceding diarrhea.	Typhoid fever without preceding diarrhea.		Total cases of typhoid fever.
		Number of cases.	Number of individuals.	Number of cases.	In 100 men with preceding diarrhea.		Number of cases.	In 100 men not having had diarrhea.	
2d Illinois	1,095	294	255	26	10.2	840	255	30.4	281
9th Illinois	1,288	283	245	9	3.7	1,043	191	18.3	200
49th Iowa	1,236	220	202	24	11.8	1,034	448	43.3	472
50th Iowa	1,097	162	160	8	5.0	937	188	20.1	196
2d New Jersey	1,153	216	202	35	17.3	951	208	21.9	243
1st North Carolina	1,164	485	435	27	6.0	729	168	23.0	195
2d Virginia	1,220	167	146	14	9.6	1,074	107	9.9	121
4th Virginia	1,274	188	171	17	10.0	1,103	155	14.0	172
1st Wisconsin	1,232	39	37	4	10.8	1,195	241	20.2	245
Total	10,759	2,056	1,853	164	8.8	8,906	1,961	22.2	2,125

That is, of 1,853 individuals who were treated for intestinal disorders 164, or 8.8 per cent, subsequently had typhoid fever.
Of 8,906 individuals who had not been treated for intestinal disorders 1,961, or 22.2 per cent, had typhoid fever.
Or, of 2,125 cases of typhoid fever 164, or 7.7 per cent, had previously been treated for intestinal disorders.
Of 2,125 cases of typhoid fever 1,961, or 92.3 per cent, had not been treated for intestinal disorders.

Cases of typhoid fever among men with or without preceding diarrheal diseases for seven regiments of the Third Division, Seventh Army Corps, Jacksonville, Fla.

Regiments.	Mean strength.	Diarrheal diseases.		Cases of diarrheal diseases followed by typhoid fever.		Number of men without diarrheal diseases.	Typhoid fever without preceding diarrheal disease.		Total cases of typhoid fever.
		Number of cases.	Number of individuals.	Number of cases.	In 100 men with preceding diarrhea.		Number of cases.	In 100 individuals without preceding diarrhea.	
4th Illinois	1,194	137	115	0	0.0	1,079	238	22.0	238
161st Indiana	1,304	145	133	9	6.7	1,171	125	10.6	134
2d Mississippi	1,217	563	454	11	2.4	763	107	14.0	118
6th Missouri	1,149	69	67	10	14.9	1,082	276	25.9	286
3d Nebraska	1,262	422	344	56	16.2	918	224	24.4	280
2d South Carolina	945	521	365	8	2.1	580	77	13.2	85
2d Virginia Cavalry	919	513	399	37	9.2	520	114	21.9	151
Total	7,990	2,370	1,877	131	6.9	6,113	1,161	18.9	1,292

An examination of these tables shows that those men who had experienced previous diarrheal attacks were much less liable to subsequent attacks of typhoid fever than those who had not had such intestinal attacks.

ORIGIN AND SPREAD OF TYPHOID FEVER IN THE SEVENTH ARMY CORPS.

This did not differ from the origin and propagation of typhoid fever in the other army corps of which we have already treated, and hence we shall only devote a few words to this subject. In referring to the progress of typhoid fever in the Second Division, which was the first to assemble at Jacksonville, we have shown that the disease was imported by five regiments of the nine originally constituting this division; and, further, that it was just in these regiments that typhoid fever most rapidly developed during June. As the men of those regiments not importing typhoid fever and in which so few cases developed in June had the same opportunity for infection from shallow wells within the vicinity of the camp, we must conclude that the importation of cases of typhoid fever was the most important factor in the origin of this disease in the Second Division. We have also seen that all of the regiments of the First Division arriving from Miami, Fla., imported the disease and that only one of the eight regiments of the Third Division failed to import cases of typhoid fever. The sources of infection were, therefore, plainly internal to the several camps, whatever chances for outside infection there may have been.

With regard to the latter, we call attention to the absence of typhoid fever in Jacksonville during the year 1898, and we give herewith a table showing the slight prevalence of typhoid fever and other fevers in that city for the years 1895–1898, inclusive; so that we must conclude that although there may have been individual cases of infection outside of the camp, the chief source of the disease was to be found

within the camp. As regards the propagation of the disease in the several organizations, the regimental histories and graphic charts should be consulted. A careful examination of these will show that typhoid fever, as it appeared in the various regiments of the Seventh Army Corps, consisted essentially of a series of company epidemics, whose discrepancies, both in the time of beginning as well as in their course and ending, were such as to preclude the assumption of a common, simultaneous, and more or less continuously acting agency as the chief means in the spread of the disease. Propagation of the disease through contamination of the general water supply can be safely excluded.

Mortality table of Jacksonville, Fla., relative to typhoid fever and other fevers which may be mistaken for it, from 1895 to 1898, inclusive.

[Deduced from statistics by health office of that city.]

Cause of death.	1895.	1896.	1897.	1898.	Total.	Average per year.	Population.
Remittent	22	8	10	5	45		30,000
Typhoid	9	5	6	9	29		30,000
Malarial	9	7	2	3	21		30,000
Typhomalarial	2	4	0	3	9		30,000
Intermittent	4	2	1	1	8		30,000
Enteric	5	1	0	0	6		30,000
Continued	4	1	1	0	6		30,000
Gastroenteric	1	0	0	0	1		30,000
Bilious	1	0	0	0	1		30,000
Total probable typhoid	57	28	20	21	126		30,000
Probable typhoid per 1,000	1.90	0.93	0.66	0.71		1.05	30,000

N. B.—During the four years 2 deaths from brain fever, 1 death from gastric fever, and 1 death from septic fever were also recorded.

We have already shown that the method in use for the disposal of excreta differed in the three divisions of this corps, the First Division being provided with flushing troughs, the Second Division with half tubs, and the Third Division with open pits dug in the sandy soil. As these divisions were otherwise placed under similar conditions as to camp sites, water supply, etc., it is interesting to observe that while the morbidity from typhoid fever in the First Division was 150.32 per 1,000 of mean strength, this reached 161.70 per 1,000 for the Third Division and the high figure of 250.30 per 1,000 for the Second Division. It should also be noted that the figures given for the Third Division only embrace cases of recognized typhoid fever and do not include probable cases, such as prolonged malarias, incorrectly so diagnosed. Had the latter been included, the morbidity per 1,000 would have approximated that given for the Second Division. Hence we see that with water carriage for its fecal matter, typhoid fever never reached as high a proportion in the First Division, although all of its six regiments arrived in Jacksonville in August, 1898, thoroughly infected with this disease, the result of a previous epidemic at Miami, Fla. With conditions ripe for its propagation, the epidemic only assumed

moderate proportions in the First Division as compared with its course in the Second and Third divisions. This we believe was largely due to the prompt removal of excreta and to the lessened chance for fly infection of food and sink infection of the person of the soldier, especially his clothing and shoes.

Relative to the spread of the disease from personal contact in crowded tents, which we have discussed in connection with certain regiments of the Second Corps at Camp Meade, Pa., we have only been able to obtain information on this point in ten companies of five different regiments in the Second Division, Seventh Corps. (For details see histories of these regiments.) These squad groups of the sick, as plotted in their tents, would appear to suggest a mode of disseminating infection which more effectively reached and acted upon certain limited groups of men while it passed by others. We believe that this would be entirely compatible with the assumption of a dominating tent, squad, or comrade infection. These observations, taken in connection with our studies of certain regiments in the Second Corps, have led us to the opinion that squad or comrade infection was a very important factor concerned in the propagation of typhoid fever in the Seventh Army Corps.

CHAPTER XIII.

COINCIDENT MALARIA AND TYPHOID FEVER.

Early in the war of the rebellion army medical officers reported the prevalence of a form of fever among the soldiers which differed in some respects from typhoid fever as observed in the Northern States. In December, 1861, a board of medical officers, consisting of Surg. A. N. McLaren, Brigade Surg. G. H. Lyman, and Asst. Surg. M. J. Asch, was appointed to determine "whether it (this fever) should be considered an intermittent or bilious-remittent fever in its inception, assuming in its course a typhoidal type or a typhoid fever primarily." The members of this board visited and inspected certain camps and hospitals and obtained information concerning others by correspondence with medical officers. They came to the conclusion that the large majority of the febrile cases then occurring among the troops were "bilious-remittent fevers, which, not having been controlled in their primary stage, have assumed that adynamic type which is present in enteric fever."

In 1862 a board of medical officers was convened for the purpose of revising the form of sick report then in use in the Army. One member of this board was Surg. J. J. Woodward. Major Woodward had spent the greater part of the preceding year with the Army of the Potomac and was familiar with the form of fever upon which the previously appointed board had reported. However, his opinion of

the nature of this fever was never in accord with the report made by the board of inspection. As has already been stated, this board came to the conclusion that the fever about which so much had been said was a bilious-remittent fever which had assumed that adynamic type present in enteric fever; in other words, this board defined the fever as a malarial fever with typhoid symptoms. On the other hand Major Woodward believed that "the prevailing fevers of the Army of the Potomac were hybrid forms, resulting from the combined influence of malarial poisoning and of the causes of typhoid fever." In accordance with the opinion of Surgeon Woodward, the board appointed to revise the form of sick report then in use in the Army suggested to the Surgeon-General that this fever be known as typho-malarial fever.

It should be clearly seen that there were among the medical officers during the war of the rebellion two very distinct ideas concerning the nature of the disease which they reported under the name of typho-malarial fever. The idea expressed by the board of investigation, that this was a severe form of malarial fever, was the most widely accepted, and, while the name proposed by Major Woodward was adopted, the opinion of the first board concerning the nature of the disease was the one generally accepted. Thus it happened that the disease was designated as proposed by Woodward, but was defined according to the opinion of the board of inspection. Ever since the first use of the name typho-malarial fever, the majority of physicians in the United States using this name would have defined it as a severe form of malarial fever. However, this was never the opinion of Major Woodward.

In a scholarly paper, read before the International Medical Congress held at Philadelphia in 1876, Major Woodward discussed what we would now call mixed malarial infections. He endeavored to show that malarial infection might modify both typhus and typhoid fevers. It must be admitted that in this paper he brought forward some very interesting and convincing historical evidence of the prevalence of such mixed infection in armies. He states:

> Is it wonderful, then, that hybrid forms of disease, exhibiting the ordinary symptoms of malarial and of typhoid fever, variously combined, should long have been observed in this country? In fact, such hybrid forms have long been observed in Europe also. In the first volume of his Institutes, published in 1781, Burserius recognized them as a group, "the Porportionata," which he defines as the compound species composed of the synochus (an old name for typhoid fever) and intermittent fever. This union, he says, occurs especially "when intermittent fevers prevail epidemically, or at least constitute the prevailing and stationary disease; for then almost all diseases bearing some resemblance to intermittents, or sporadic or intercurrent fevers, of whatever other kind, are combined with the intermitting fevers." Herman Schmidt, in his account of the so-called summer fever, which was epidemic throughout Europe during the year 1827, has still more elaborately described as the form of fever then most generally prevailing a combination of intermittent fever with the endemic typhus of Europe (our typhoid fever). He had subdivided the resulting hybrid forms into two chief classes: (1) *Typhus inter-*

mittens subintrans, which he defines as a combination of typhus (our typhoid) and intermittent fever, with a preponderance of the typhus element. (2) *Febris intermittens typhosa*, which he defined as a similar combination, with a preponderance of intermittent fever. I would refer you to his elaborate treatise for many suggestive details. Naumann has quoted, with approval, the views of Burserius and Schmidt, and mentions corroborative observations by several other writers, to which I might add many more did the scope of this discourse permit.

Woodward also refers to the studies of the Walcheren fever that prevailed among the English army invading Holland in 1809, as reported by Dawson and Davis.

In the paper referred to Woodward states:

I never meant this term (typho-malaria) to represent a specific type of fever, but intended it to designate all the many-faced brood of hybrid forms resulting from the combined influence of the causes of malarial fever and of enteric fever.

In another place he states:

And this brings me, at length, to answer the question, Is typho-malarial fever a special type of fever? and I reply unhesitatingly that it is not. I, at least, am free from the blame of that error, if anyone has fallen into it. In my first published account of typho-malarial fever I expressly denied that it could be regarded as a new disease. "Much rather," I said, "should it be considered simply as a new hybrid of old and well-known pathological conditions, in which the exact train of symptoms is as variable as the degree of preponderance attained by each of the several concurring elements." And this is the view which I advocate to-day. The essential point which I desire most to impress upon you is the recognition of the group of hybrids between typhoid fever and malarial fevers.

Furthermore, Woodward advocated the idea that typho-malarial fever was modified in individuals suffering under the scorbutic taint. He says:

Now, when either of the forms of typho-malarial fever which I have described occurred in individuals suffering under the scorbutic taint the symptoms were modified to a degree corresponding to the intensity of the scorbutic condition. The effect of the complication was to increase the tendency to mental and bodily prostration during the disease, to tardy convalescence subsequently, and to increase the frequency of petechial and purpuric eruptions and of hemorrhages from the nose and bowels. Sometimes the characteristic scorbutic condition of the mouth was developed during the progress of the fever when it had not previously made its appearance. When the characteristic typhoid process was developed in individuals laboring under a marked scorbutic taint, the symptoms closely resembled those of spotted typhus. Fatal hemorrhages from the bowels were common in such cases, and on dissection the lower patches of Peyer were found converted into dark red or black pultaceous sloughs of considerable size and thickness. I suppose the scorbutic condition to have modified the typhoid ulceration in such cases just as we often see it modify the condition of superficial ulcerations or of gunshot wounds.

Major Woodward closes the paper above referred to with the following statement:

If I have rightly presented the subject, a just appreciation of the hybrid forms which I have urged on your attention to-day is a matter of grave practical importance, not merely as a question of military medicine, though most important in that connection, for I take it that whenever again hereafter an army, recruited in

a comparatively nonmalarial region, shall campaign on malarial soil, these hybrid forms will appear once more in epidemic proportions; but meanwhile, I suppose, in sporadic or endemic wise, we shall continue to have these cases to deal with in civil practice in all the miasmatic regions of our Middle and Southern States, and their ready comprehension is therefore a question of serious moment to every American physician engaged in practice in such localities.

Adopting the nomenclature suggested by Woodward, there were reported to the Surgeon-General's Office, beginning with July 1, 1862, and ending June 30, 1866, 57,400 cases of typho-malarial fever, with 5,360 deaths.

Since the war of the rebellion the physicians of this country have been divided in their opinions concerning the so-called typho-malarial fever. A considerable number of those practicing in the Southern States have continued to use this term, but the majority of these have used this designation to represent what they believe to be a severe form of malarial fever, and have never placed Woodward's interpretation upon the nature of the disease. On the other hand, a large proportion of the physicians practicing in the Northern States have denied the existence of this hybrid infection. It is quite evident that the ultimate solution of this problem had to wait upon the discovery of the plasmodium of malarial fever by Laveran and of the bacillus of typhoid fever by Eberth.

Laveran[1] appears to have been the first to record cases of so-called mixed malarial and typhoid infection. In 1884 he reported a case of intermittent fever occurring during convalescence from typhoid fever, and a second case in which the malarial attack immediately preceded and closely followed the attack of typhoid fever. These cases are as follows:

Case 1.—Soldier; age 22; admitted to military hospital at Constantine, Algeria, August 2, 1882. In March, 1881, he was said to have had a fever which lasted three days, with herpes labialis. He recovered without quinine.

July 31.—The first symptoms of his disease were malaise, headache, thirst, high fever without chill, and general weakness; fever continued without marked remission until entrance to hospital; temperature, 40.8° a. m., 40° p. m. Typhoid condition well marked, slight diarrhea, pain upon pressure in the right iliac fossa. Although the diagnosis of typhoid fever appeared probable, quinine was prescribed for a few days.

The diagnosis of typhoid fever was later fully confirmed, although rose spots were not present.

August 11.—Defervescence beginning.

20th.—Temperature normal; the chart is typical of typhoid fever.

29th.—The patient reported that he had a chill for several days at about 7 p. m.; temperature 39.5° p. m.

30th.—Temperature 37.2° a. m., 38.5° p. m. Examination of the blood made at 8 a. m. shows a large number of pigmented malarial parasites, both free and intracorpuscular; quinine was given.

31st.—Apyrexia; parasites in the blood reduced in numbers; quinine continued.

September 3.—No parasites found. Recovery followed.

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[1] Laveran: Traité des Fièvres Palustres, Paris, 1884.

CASE 2.—Soldier: age, 23; admitted to hospital January 25, 1883. Previous history of intermittent fever in August, 1882. Present sickness beginning on January 20; characterized by daily chills at 2 a. m.

January 24.—Temperature 40.2° a. m., 38.9° p. m. Anæmia well marked; mucous membranes pale; general emaciation and weakness; anorexia. Examination of the blood at 2.30 p. m. shows pigmented malarial parasites, free and within the blood corpuscles; also pigmented leucocytes; quinine given.

25th.—Temperature 38.2° a. m., 38.4° p. m.; quinine.

Under this treatment the parasites disappeared, temperature returned to normal, and appetite increased.

February 8.—Patient complains of inability to sleep; headache, and general malaise for two or three days. There has been no chill. Temperature 39.5° a. m., 40.6° p. m. Examination of the blood failed to show malarial parasites. Quinine given.

9th.—Fever continues. Temperature, 39.7° a. m., 39.9° p. m.; prostration well marked; general malaise, headache, insomnia, slight diarrhea, and some pain on pressure in the right iliac fossa; quinine continued.

11th.—Temperature 39.3° a. m., 40.3° p. m.; rose spots appeared on the abdomen; quinine discontinued.

15th.—Defervescence beginning.

20th.—Temperature normal on the seventeenth day of the disease.

28th.—Patient anæmic and weak. Examination of the blood shows no malarial parasites. Condition continued to improve until March 8, when a chill occurred at midday followed by fever; temperature rising to 40.3°. Examination of the blood showed malarial parasites of the tertian variety; quinine given. From this time under the use of quinine convalescence was rapid.

In this country, Kinyoun,[1] in a study of malarial and typhoid fevers in the United States Marine Hospital, New York, recorded under the title of "entero-malarial fever" cases showing "a combination of malarial and enteric fevers, which clinically presented some deviations from the general course of either disease."

He divided his cases into two groups:

I. Cases in which the symptoms of malarial fever predominate, masking the enteric lesion; 2 cases.

II. Cases in which the symptoms of enteric fever are most prominent; 3 cases.

The following is the history of the cases belonging to the first group:

CASE 1.—Patient taken sick two days before admission, the attack commencing with a chill followed by fever, marked by a remission. A microscopical examination of the blood was made and "a large number of the *plasmodia malariæ* was found free both in the serum and within the blood corpuscles. This established the diagnosis of malarial fever of the remittent type." On the fifth day after admission there appeared on his abdomen several suspicious-looking spots suggestive of enteric complications. On the day following he had slight epistaxis, a tendency to diarrhea and tenderness in the right iliac fossa. The case afterwards ran the typical course of typhoid fever. Patient recovered.

CASE 2.—The symptoms were less pronounced than in the first case. "The *plasmodium malariæ* was found in the blood in abundance, and later the typhoid bacillus was isolated from the stools."

[1] Weekly Abstract of Sanitary Reports, Vol. V, 1890.

Concerning the 3 cases of Group II, the author says: "The enteric symptoms were well marked, giving a clear history of the disease." There were lassitude, etc., "followed by diarrhea, epistaxis, and tympanites, and in one case slight hemorrhage." In these cases the parasite was found "confined to the corpuscle, not free in the blood."

In one of these cases, during the third week when convalescence appeared to have been established and temperature was normal, he had a sudden access of fever two days in succession. Examination showed the *plasmodium malariæ*. Patient recovered.

The other cases of this group died, 1 from peritonitis and 1 from pneumonia.

Kinyoun does not record the variety of the parasite found in his cases.

In 1894, W. Gilman Thompson, in a paper before the Association of American Physicians, reported 3 cases of mixed malarial and typhoid infection. The following is taken from Thompson's history of one of his cases:

On his admission his appearance suggested typhoid fever, and he was treated accordingly by the Brand method of cold tub-bathing. There was slight enlargement of the splenic area of dullness, great prostration, diarrhea, and a typical typhoid tongue, dry, coated on the dorsum, with thin red margins and swollen papillæ. There was continued fever, which lasted for seven weeks, and during this period the patient developed the following symptoms: A genuine typhoid eruption, there being some forty distinct rose spots on the abdomen and chest, which appeared in successive groups: hemorrhages from the bowels, of which there were four or five of considerable amount; tympanites, bronchial catarrh, slight albuminuria with granular casts, semistupor and delirium, subsultus, great prostration and emaciation, and the facies of the typhoid condition.

On the thirteenth day of the illness there was a severe chill, lasting about three-quarters of an hour, and so violent that the patient shook the bed. It was accompanied by a rise of temperature to 106.6° F., but there was no sweating. During the third week two other chills occurred of equal violence. As the first took place before the hemorrhage, and also before the eruption became decisive, and as there was nowhere evidence of suppuration, it appeared possible that there might be error in the diagnosis, and the blood was carefully examined for the malarial plasmodium. It was found in exceptionally large numbers in the red corpuscles and also independent of them. When the next chill and exacerbation of temperature occurred quinine was given hypodermically, with the effect of reducing the temperature 4.5° (105.5° to 101° F.). This treatment was several times repeated, and on one occasion at the end of the third week the temperature was temporarily reduced from 106.4° to 99° F. No more chills occurred after the beginning of the fourth week, but the use of quinine was continued by the mouth, and the bathing, previously interrupted by the hemorrhages, resumed. The patient made a good recovery, and after fifty-five days in the hospital was discharged, cured.

With reference to these cases Thompson says:

In the first case reported the plasmodium became active during the height of the typhoid disease. In the second and third cases the malarial symptoms remained latent (although the plasmodium must have been already present) until the force of the enteric infection had been completely expended, when they assailed a body weakened by a fever of considerable duration.

Thompson believes that while it is unwise to accept the term typho-malarial fever as indicating a third form of disease, it can not be denied that the two diseases may coexist.

Osler[1] reports 3 cases in which "there was a definite history of malaria within a few months of the onset of the typhoid fever," and 1 case in which a patient having malaria subsequently developed typhoid fever. The history of the latter case is as follows:

The patient, a man aged 20, had, during sixteen days prior to admission, headache and cough, occasional nose-bleeding, and three chills. On admission, October 16, the temperature was 100°, but fell in the early morning of the 17th to 96°. The malarial parasites were found to be present in the blood. He was ordered quinine, 4 grains, three times a day. On the 17th the temperature began to rise a little after 12 a. m., and at 3.30 p. m. he had a chill, after which the temperature rose to nearly 105°, then fell throughout the next night and was normal at 8 a. m. The case was one of ordinary tertian intermittent, and the quinine was continued. On the 18th, 19th, 20th, 21st, and 22d the temperature was normal or subnormal. A two-hourly temperature had been taken. Up to 8 a. m. of the 22d he had taken 80 grains of quinine. He had no more fever, and the malarial parasites had disappeared from the blood. At 8 a. m. on the 22d the temperature was 97.5°. At 4 p. m. it was 98°. It gradually rose through the evening, and at 12 midnight it was 102.5°. The next morning it was 102.2°, rose throughout the day, and from 4 to 8 p. m. was at 105°, so that within the twenty-four hours from 4 p. m. on the 22d to 4 p. m. on the 23d the temperature had risen 7°. Naturally we thought this was a recurrence of malaria, in spite of the administration of quinine, of which he had had 96 grains up to 10 a. m. on the 23d. From 8 p. m. on the 23d throughout the 24th and 25th, the temperature remained practically between 103° and 105°, uninfluenced by the quinine (which was continued) and only influenced slightly by sponging. The quinine was continued until noon on the 26th. The whole appearance of the man was suggestive of typhoid fever, and subsequently spots appeared, the spleen enlarged, and the disease ran a perfectly normal course, typical, but of great severity, the temperature not falling to normal until between the fifth and sixth weeks.

Osler further says:

There was no case with the character of the two diseases so blended that it seemed a compound or hybrid malady, nor was there an instance in which the manifestations of the two diseases were concurrent.

The same author[2] records a case of continued malarial fever, lasting from September 28 to October 7, 1894, in whose blood the æstivo-autumnal parasite was found during the attack, and which was followed by a severe typhoid fever beginning on November 6, or thirty days later. The case ended in recovery.

Vincent,[3] a French army surgeon, on duty at the bacteriological laboratory of the Hospital du Dey in Algeria, records 17 cases of mixed malarial and typhoid infection, which he designates as "*fievre typho-palustre.*"

These cases were observed among soldiers who had served in Mada-

[1] Johns Hopkins Hospital Reports, Vol. IV, 1895.
[2] Johns Hopkins Hospital Reports, Vol. V, 1895.
[3] Mercredi Medical, Paris, 1895, pp. 573–579.

gascar and Algeria. Although the clinical picture was a variable one, sometimes partaking of that of malaria and sometimes of that of typhoid fever, as a rule the typhoid symptoms were dominant. The earliest symptoms were manifested by a rise of temperature, with or without chill, severe headache, sometimes epistaxis, and general body pains. Once established, the fever continued, often irregular in its course, or higher in the morning than in the evening. In 2 cases the initial fever was of short duration and was followed by an almost normal temperature, the latter interrupted by an occasional rise. The pulse followed the oscillations of temperature, remaining in the meanwhile frequent. It often varied from 130 to 150 or more to the minute. It was dicrotic, compressible, sometimes threadlike, and was accompanied by cardiac distress and irregularity.

Profound stupor, delirium, great excitement alternating with collapse, earthy hue of countenance, dusky, dry lips and tongue, and marked albuminuria, symptoms which indicated the severity of the infection, were to be seen in all of these cases. Sometimes the disease was ushered in by coma like that of pernicious malaria, death occurring during the first week. Thoracic complications (bronchitis and pneumonia) were almost constant. Rose spots were present in 12 cases. Iliac tenderness was present; in some cases constipation. Diarrhea, slight or profuse, was the rule. One patient died with choleriform symptoms. Two cardinal symptoms were never lacking—the earthy color of the face and the marked enlargement of the spleen. There were also enlargement and tenderness of the liver.

While death might be caused by the intensity of the infection, it was often in consequence of complications such as myocarditis, parenchymatous nephritis, gangrene of the lung, lobular pneumonia, abscess of the kidney and spleen, peritonitis, etc.

Convalescence was slow and was sometimes marked by isolated paroxysms.

In all of these patients microscopic examination of the blood made during life and at the beginning of the disease showed, in variable numbers, the malarial parasite (amœbic, segmenting forms, and crescents) except in 1 case, in which large doses of quinine had been taken. In this case large numbers of the parasite were found in the tissues of the spleen after death.

Death occurred in 8 of these cases. Swelling or ulcerations of Peyer's patches were found in all in varying degree. These changes were often slight. Once or twice they were reduced to a simple psorentery (simple psorenterie). The mesenteric glands were enlarged. The spleen constantly increased in size, weighing in one case 700 grams and in another 900 grams, and its surface was of a dark color. The liver was enlarged, of a brown color and soft consistency. The kidneys showed the lesions of parenchymatous nephritis. Sections of the liver showed marked pigmented infiltrations of the capillaries. The same pigmen-

tation, yellow or black, was found in the spleen. Sections of the spleen showed sometimes a large number of malarial parasites and crescents.

In all of the fatal cases cultures from the spleen gave a motile bacillus, which did not liquefy gelatine, and which grew upon potato as a moist, colorless layer. This bacillus grew well in bouillon to which carbolic acid had been added, and did not ferment lactose. It showed all of the characteristics of the bacillus of Eberth.

As the result of the microscopic study of the blood, and of the pathological and bacteriological findings at the autopsy, Vincent concludes that the disease under consideration is "none other than a mixed infection due to the association of the typhoid bacillus and the malarial parasite. Whether the typhoid germ developed secondarily upon a soil already invaded by the malarial poison (which appears to be most frequently the case), or whether the two infections are coincident, they produce by their conjunction a remarkable disease, of hybrid character, sometimes partaking of the nature of remittent malarial fever and sometimes of that of typhoid fever."

In 1897 Da Costa[1] reported 1 case:

Male; age, 25 years; admitted to hospital November 9. Began more than three weeks ago to have chills every second day, followed by high fever and sweating. Has had some diarrhea for two weeks. Upon admission he had continued fever and exhibited features of typhoid fever. Temperature rose to 102.4° in the evening.

10th.—Temperature, a. m., 100°; p. m., 103.8°. Thereafter the fever followed the course of typhoid. There were rose spots and pea-soup evacuations.

Examination of the blood (date not stated) "showed various forms of malarial organisms, though not the crescentic forms."

Lyon[2] reported the following observation:

Case.—Male; age, 48; admitted to Johns Hopkins Hospital January 5, 1898. Well-established history of previous malarial attacks during June, August, and October, 1897. Present illness dates from December 18. Between this and January 5, 1898, he had daily chills, slight, and confined to his back. No sweats, cough, or epistaxis. On admission, temperature, respiration, and pulse normal; tongue dry and coated; abdomen full and rather tense, but not tender; no gurgling in iliac fossæ; a few rose spots on abdomen; bowels constipated; Ehrlich's diazo-reaction in the urine; no malarial organisms in the blood; Widal's reaction absent. During the forty-eight hours following admission two suspicious febrile paroxysms occurred, without chills or sweating. Repeated examinations of the blood for malarial parasites were negative. The case pursued the characteristic course of typhoid fever, and was of average severity. Widal positive. Temperature reached normal on the thirty-first day. Nine days later there was a febrile paroxysm, without chill or sweating. This was followed by a similar paroxysm two days later, and a third paroxysm two days after this. Examination of the blood during the third paroxysm showed numerous full-grown pigmented tertian malarial organisms and a few young hyaline forms in the red-blood corpuscles. Quinine was given in full doses, and no further evidence of malarial fever was seen. The case ended in recovery.

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[1] International Clinics, Vol. II, Seventh Series, July, 1897.

[2] American Journal of the Medical Sciences, January, 1899.

It will now be interesting to inquire whether or not the conditions prevalent among our troops during the late war with Spain have thrown any light upon the so-called typhomalarial fever as defined by Woodward. Let us repeat that Woodward believed that this disease was due to the coexistence of the malarial and typhoid poisons in an individual. He never taught that typhomalarial fever was only a severe form of malarial infection.

We will first record the results obtained by those medical officers who were assigned to general hospitals or to military camps for the purpose of making expert blood examinations.

Acting Asst. Surg. J. J. Curry, U. S. Army, on duty at the general hospital, Fort Myer, Va., to which hospital many cases were sent from Camp Alger, Va.; Jacksonville, Fla.; and Montauk Point, N. Y., reports as follows:

We have met in our investigation 12 cases in which both the malarial parasites were found in the blood, and at the same time the Widal reaction was obtained. In but 1 of these cases was the malarial parasite found in the course of the fever of typhoid. This case is of unusual interest, and I will refer to it later. In 8 of the cases the malarial parasite appeared, with accompanying symptoms, during the convalescence. In the remaining 3 cases the soldiers had had typhoid fever from two to six months previously to the malarial attack. At the time the blood of these cases showed the malarial parasite it also gave the Widal. These cases, of course, do not come under the head of mixed infections, but their mention serves to illustrate a possible source of error in cases reported as mixed infections, simply because the Widal was obtained at the same time that the malarial parasite was found in the blood. In 8 of these cases of mixed infection the malarial parasites occurred during convalescence only. In the other case the parasite was found both in the first week of the disease and on the eighteenth day of normal temperature during convalescence. All of these men came from Cuba and had had malaria there. The earliest period at which the malarial attack occurred during convalescence was on the fourteenth day of normal temperature; 1 case on the seventeenth, 1 on the eighteenth day, 1 on the twenty-second day, and the others at varying intervals from one to two months after the temperature had reached normal.

The case in which the parasite occurred during the acute stage of his typhoid deserves special mention. This soldier, a man about 27 years of age, native of Massachusetts, a first-class private, Signal Corps, U. S. Army, was in Cuba with the Fifth Corps during the Santiago campaign.

History.—He had chills and fever at Santiago July and August, 1898; came to Montauk Point, and then to the command at Fort Myer about November 1. On November 17 he had a chill and sharp rise of temperature; blood examination showed double tertian (2 crops of tertian malarial parasites, 1 mature, 1 half grown); his temperature reached normal on the 18th, but on the 20th the temperature was 100°; the temperature rose to 103° on the 22d; blood examination showed the æstivo-autumnal parasite on this day; no tertian parasites; Widal, negative. Blood was examined daily; the æstivo-autumnal parasites (ovoids, crescents, and round bodies) were found in gradually lessening numbers until the 27th day of November, i. e., up to the 8th day of continuous fever, then they disappeared; the temperature came down to normal after nineteen days of fever; the highest point recorded on the temperature chart was 104° on November 27. After repeated examinations for Widal, a positive reaction was obtained on the 25th day of the

disease (after the temperature had been normal nearly a week). The man's temperature remained normal until December 26, when he had a sharp chill, the temperature rising to 106°; the temperature fell to normal, but was followed by another chill and rise to 103.4° on the next day. Examination of blood showed double tertian (two crops of the malarial parasite). The first chill occurred after eighteen days of normal temperature.

In these 9 cases the malarial infection was in 5 single tertian, in 2 double tertian, and in 2 double tertian and æstivo-autumnal.

We have found malaria complicating, or rather recurring, during the convalescence from other diseases, and even in surgical cases. There appears to be no connection between typhoid and malaria other than that an attack of typhoid fever, by lowering the individual's resisting powers, gives favorable soil for a recurrence of his malaria, or affords a suitable condition for a fresh invasion by the malarial parasite.

Probably careful investigation would reveal the fact that convalescents from diseases other than typhoid show quite as large a percentage complicated by malaria.

Acting Asst. Surg. James Carroll, U. S. Army, who made blood examinations at both Camp Alger, Va., and Jacksonville, Fla., failed to find the malarial parasite in the cases of fever examined by him.

Dock, of Ann Arbor, who was assigned to duty at Chickamauga during the early part of September, 1898, and afterwards visited the camps at Knoxville, Tenn., and Middletown, Pa., sums up the result of his painstaking labors as follows:

I found no evidence of combined typhoid and malarial infection. Among so large a number of cases of typhoid fever in men from all parts of the country some cases of that kind must have occurred.

Dr. James Ewing, who was detailed by Surgeon-General Sternberg to duty at Montauk Point, N. Y., to render what assistance blood examinations might give in the diagnosis of fevers among troops arriving from Cuba, makes the following valuable observations:

In 69 cases giving a distinct history of recent malarial fever and exhibiting similar evidence in the blood in the form of severe anæmia, pigmented leucocytes, often atypical pigmented intracellular bodies, and in some cases a few plasmodia, the question of a double infection with typhoid fever and malaria had to be considered.

Of these, 40 were reported as cases of typhoid fever in anæmic and malarious subjects. In some of these cases the disease began with one or more short rigors repeated on successive days, after which the disease progressed with the usual symptoms of typhoid fever. In one such instance (791) tertian parasites were found during the first few days and before typhoid fever was suspected, but they disappeared rapidly under quinine and were not again seen. The patient died from peritonitis in the fourth week.

In another case (514) the usual history of Cuban malaria was interrupted by the development of typhoid fever with all essential symptoms; plasmodia could not be found in the blood, but in the second week of convalescence tertian chills and fever developed and tertian parasites were found in the blood.

In a third case (683) the history indicated the slow onset of typhoid fever in Cuba, which was safely withstood without quinine, but in the second week of convalescence, tertian chills and fever supervened and tertian parasites were found in the blood.

There were other cases (1. 3. 51, 115. etc.) illustrating the same behavior of the malarial infection during the course of typhoid fever.

Further evidence of the usual incompatibility of malarial and typhoid fevers were furnished by the 2 fatal cases of typhoid fever in malarious subjects that came to autopsy (523. 683). There no parasites could be found in the blood during life, but in smears from the spleen and marrow diligent search revealed the presence of a very few rings and crescents, with much old malarial pigment.

The reason why the blood was examined in 159 cases of typhoid fever, was the intermittent character of the fever, which was exhibited in patients both with and without malarial antecedents. In no case of undoubted and established typhoid fever were malarial parasites found in the blood in connection with any of these sudden rises of temperature, but only at the onset of the disease or during convalescence.

On the other hand, many patients whose blood contained numerous parasites were seen in the typhoid state, but there was always some essential symptoms lacking to confirm the diagnosis of typhoid fever, while the subsequent course of the disease, where observed, demonstrated the purely malarial character of the fever.

The patients might suffer from epistaxis, hematemesis, bloody stools, tympanites, a few rose spots, though oftener herpes, diarrhea, and delirium, and in some a partial Widal's reaction was obtained. But the intestinal symptoms were inconstant or referable to dysentery or simple diarrhea. from which many of the malarial cases suffered, and these patients never showed subsultus, or cracked tongues, and they did not die, or if they did dysentery and malaria were demonstrated at or before the autopsy.

In another group of 29 cases the absence of any large number of parasites and presence of typhoidal symptoms left a reasonable doubt regarding the diagnosis. These cases seemed almost certainly malarial on account of the previous history, the facies, the anæmia, and usually the sudden recovery at the turn of the disease, while in 7 of them a few parasites were found in the blood.

On the other hand, the suspicion of typhoid fever was raised by the continued fever, abdominal symptoms, and general typhoidal state, although symptoms of typhoid fever were not present in distinct and convincing form. A moderate reaction with Widal's test was sometimes obtained in these cases. but this evidence failed to be convincing after sharp reaction had occurred in a case of dysentery (269) and in a cinchonized case of pernicious malaria (328).

It is possible that some of these patients suffered from both active malaria and typhoid fever, but there was no positive indication that the latter infection was present. In the cases that came to autopsy there was never any doubt of the nature of the disease. It was either typhoid fever or malaria, but never both, although microscopical evidence of dormant malarial infection was found in at least 2 cases of typhoid fever.

In short, in spite of every painstaking effort the attempt to find a case of typhoid fever and active malaria progressing simultaneously was unsuccessful.

From the study of this group of cases it is concluded:

(1) That typhoid fever is to a large extent incompatible with active malarial fever, and that during the course of the former the latter infection is usually suppressed.

(2) That the presence of old malarial infection may alter the course of typhoid fever through the anæmia, but that active sporulation of the malarial parasites very rarely occurs during the course of established typhoid fever.

(3) On the other hand. since malarial paroxysms often reappear during convalescence. a scanty growth of the parasite must often persist during the course of typhoid fever, and it is possible that some of the irregularities of temperature observed in these cases are referable to this partly suppressed growth.

(4) That the anatomical evidence of a post-mortem examination is much needed to demonstrate the existence of typhoid fever in cases showing active malarial paroxysms.

Acting Asst. Surg. Charles Craig,[1] U. S. Army, who spent several months at the Sternberg Hospital, Chickamauga Park, Ga., reports a case of combined typhoid and quartan malarial fever, the first case to be placed on record in which the quartan parasite has been found.

History.—Male; malaise, constipation, and headache, with evening temperature of from 101° F. to 102° F. from September 29 to October 5, on which date he was admitted to hospital. The previous evening he had a slight chill. On admission the symptoms were gurgling and tenderness in right iliac fossa; dry, hot skin and typhoid tongue. Later there was tympanites, epistaxis, and rose spots.

October 12, or about the twelfth day of disease, Widal reaction pronounced.

15th.—Temperature a. m., 100° F., when he had a slight chill with rise of temperature to 103.4° F. Evening temperature 101° F., and for the succeeding two days it ranged from 101° F. and 102° F.

18th.—Seventy-two hours after the first chill a second and severer chill occurred. Examination of the blood showed the quartan parasite in abundance. The patient's general condition was markedly worse.

21st.—A third paroxysm, the temperature rising from 99.2° F. to 104.6° F. This was followed by a fourth and fifth paroxysm on October 25 and 28. Large doses of quinine prevented their return. The case terminated fatally.

Craig's description of the parasite and the chart accompanying the description prove that the organism was of the quartan variety.

Da Costa[2] reports 10 cases of typhoid fever among soldiers under treatment at the Pennsylvania Hospital, proved to be such by clinical symptoms, and in nearly every instance by the Widal test, in which also the malarial parasite, generally of the tertian variety or of the æstivo-autumnal type, was present.

The soldiers came from Camp Meade, Pa., except one, who had been in Porto Rico.

Da Costa says that attention is nearly always called to the malarial complication by the occurrence of a chill. These chills came on late, and sometimes not until a relapse. In only one instance of the 10 did the chill happen in the early part of the typhoid fever. In 1 case the chill occurred on the twenty-sixth and twenty-eighth days of the disease, and the tertian parasite was found on the latter date. In a second case, "late in the disease, rises of temperature occurred from normal to 100.8°, without chills; the malarial organisms of tertian type were found during these fever rises." In a third, the chill occurred on the fifth day after admission, followed by a temperature of 106°. Tertian parasites in unusual number were found. In a fourth case the chills occurred on the forty-seventh day of the disease; the type of the plasmodium was not well defined.

Da Costa gives, as a striking illustration of late appearance, a case

[1] The Philadelphia Medical Journal, June 17, 1899.

[2] "Malaria with typhoid fever." The Philadelphia Medical Journal, May 6, 1899.

in which it was only during the third relapse and on the eighty-eighth day of the disease after a hard chill that malarial organisms were found. The author's experience teaches him that cases of mixed malarial and typhoid infection are distinguished by chills and by the long duration of the fever.

Muehleck,[1] as the result of the careful study of the blood of 90 soldiers admitted to St. Agnes Hospital, Philadelphia, reports the presence of the malarial parasite in 7 instances. Dr. Muehleck has kindly informed us that in all the cases in which the parasite was found the soldiers had come from Porto Rico or Cuba. The period of the disease at which the parasite was found was as follows: During the second week, 1; third week, 1; fourth week, 3; undetermined, 2.

The varieties of the parasite are not stated. They are described as "extracorpuscular or intracorpuscular bodies, which in some instances contained pigment. These bodies were spherical, irregular in outline, and, as first stated, sometimes contained pigment which, at least in the intracellular variety, was usually gathered in or near the center of the body. In two instances sluggish, amœboid motion was observed, while in the rest the bodies were quite motionless. * * * Evidences of rosette formation or of sporulation were never observed, nor did we ever succeed in finding rings, crescents, or ovoid bodies belonging to the æstivo-autumnal variety."

Withington[2] reports 3 cases of typhoid fever coincident with malarial infection and 4 cases of typhoid in which the parasite was found during convalescence. Withington's cases occurred among soldiers who had returned from Cuba; the variety of the parasite was æstivo-autumnal in 6 cases; in 1 the variety is not stated.

The history of one of the coincident infections with malaria and typhoid is as follows:

J. A. F., aged 18, of the Second Massachusetts Volunteers, was sick and in the hospital in Cuba about July 18 with chills and fever. At that time some vomiting and diarrhea, with bloody stools. Came to Montauk Point and thence went to his home in Orange, Mass., but did not feel well at either place. About September 10 had chills and fever for five days.

Entered the hospital September 24, at which time he had had no chill for eight days. Some diarrhea, but lately constipation. The enlarged spleen could be felt, and there was a limited number of rose spots. The plasmodia malariæ were found. The Widal test was negative on September 30. On the night of October 4 he was seized, while in the act of defecation, with some pain in the abdomen, and the temperature dropped 2°. The next morning the abdomen was found moderately distended, muscles rigid, tympany general except in left flank, where there was dullness. He failed during the day and died at 10.45 p. m. October 5.

The autopsy showed a marked malarial spleen, much enlarged (weight 430 grams), symmetrical, of dark, slate color. The follicles could not be made out;

[1] "Results of the examination of the blood of 90 soldiers ill with typhoid at the St. Agnes Hospital." The Philadelphia Medical Journal, May 20, 1899.

[2] "Coincident malaria and typhoid infections as seen among our returned soldiers." Report of the Boston City Hospital, 1899.

spleen fairly firm, little pulp on scraping; microscopically, much black pigment in the cells. There were also numerous typhoid ulcers, one of which, at a point 55 cm. above the ileocæcal valve, had perforated the bowel, causing general fatal peritonitis.

The author also records 4 cases in which, as he states, the probability seems very strong of a typhoid supervening upon a malaria.

We quote the history of one of these cases.

J. W., aged 25, Seventh U. S. Infantry. Two weeks before leaving Cuba had chills and fever for six days. Recovered. Again chills and fever on transport from Cuba. Felt well while at Montauk until September 5. Then malaise, headache, and diarrhea. Entered hospital September 13. Rose spots; Widal reaction positive; no plasmodia. His temperature ran a fairly characteristic typhoid course, becoming normal on October 12. On the 18th a chill while in bath. Temperature rose 3° and returned to normal. No search for plasmodia appears to have been made on this day. For the following week there was some fever, which was supposed to be a recrudescence of the typhoid. A slow recovery with great prostration. The record shows no plasmodia at any time.

Concerning these cases, Withington says:

The evidence of primary malarial infection while in Cuba is as strong as it can be without microscopic demonstration, but the malaria was generally in abeyance during the progress of the typhoid, the latter disease running its course in some cases typically, in others more or less atypically.

The author also records 3 cases in which the sequence was (1) malaria, (2) typhoid, (3) malaria, and remarks that "each of these seemed to hold the field alone for the time being, the original malaria becoming dormant while the typhoid was in progress, so that the latter disease was in all respects unmodified, and then with recovery of the typhoid the malaria reasserted itself as before."

The following case is given in illustration:

J. C. G., aged 23, Fourth U. S. Infantry. Had a sudden onset of fever August 25. There were chills, fever, and sweating of daily occurrence. Says he was cured of this at Montauk. Entered hospital September 6. Diarrhea; five or six dejections daily; green to dark; slimy: twice bloody. Pain and tenderness about umbilicus. No plasmodia found. The fever reached normal for one day, September 13; for the next ten days ran about 100°, and on September 22 the Widal test was positive. From September 28 the fever was higher (102°), but had gone by October 6, and the patient was convalescent. October 20 plasmodia were present, the patient having on that day a chill which shook the bed, with temperature nearly to 105°. There was no further manifestation of the disease after this.

From the Massachusetts General Hospital, through the kindness of Dr. Vickey, we are able to report the following cases:

Case I.—Soldier; age, 28; regular; Cuban service. Admitted August 23, 1898. Widal positive; crescents in blood; afebrile after first day. Diagnosis: Malarial remittent-typhoid convalescent. Transferred to another hospital. Had another relapse, but whether typhoid or malaria is unknown. Termination unknown.

Case II.—Soldier; age, 24; regular; Cuban service. Admitted September 6. Widal positive and ovoids on September 10. Diagnosis: Typhoid fever-malarial

remittent. Temperature very irregular: remained subnormal after three days; quinine administered. Recovery.

CASE III.—Soldier; age, 26; Volunteer; Cuban service. Admitted September 6. Widal positive; chill on day of entrance with a temperature of 105.5. Double tertian parasites. Quinine administered with no further rise of temperature. Recovery.

CASE IV.—Soldier; age, 22; Regular; Cuban service. Admitted September 13. Widal positive. Symptoms quite typical of typhoid. Tertian (?) parasites; no marked irregularity of temperature due to malaria. Dr. Shattuck thinks the malarial complication probably remittent. Recovery.

CASE V.—Soldier; age, 23; Regular; Cuban service. Admitted October 15. Widal positive; tertian parasites in blood: afebrile after first day. Recovery.

Through the kindness of the medical superintendent of the Lakeside Hospital, at Cleveland, Ohio, we are able to report the following cases in which the blood examination was made by Dr. E. P. Carter:

CASE I.—B. P., Company F, Fifth Ohio Volunteers. Blood examination showed both the Widal reaction and the æstivo-autumnal parasite. Death resulted.

CASE II.—J. R., Company A, Fifth Ohio. Blood examination showed both the Widal reaction and the malarial parasite. The form of the latter is not stated. Patient recovered.

CASE III.—G. R., Company C, Fifth Ohio. Blood examination showed both the Widal reaction and the plasmodium malariæ. The variety of the latter is not stated. Patient recovered.

CASE IV.—C. G., Company B, Fifth Ohio. Blood examination showed the plasmodium and gave Widal reaction. Variety of parasites not stated. Recovery.

CASE V.—A. H., Company L, Fifth Ohio. Blood examination showed the plasmodium and gave Widal reaction. Type of parasite is not stated. Termination not given.

CASE VI.—J. J. F., Battery A. Blood examination showed both the Widal reaction and the æstivo-autumnal parasite. This man developed amœbic dysentery and died.

C. R. Grandy[1] (typho-malarial fever) reports two cases:

CASE I.—Had a chill in Santiago; was quite ill; but recovered sufficiently to come to this country; went to Camp Wickoff, Montauk Point, L. I.

August 27.—Had a chill, with temperature 105°.

28th.—Blood contained pigmented tertian parasites. Attack responded to quinine.

September 11.—Patient had chill.

13th.—Two sets of tertian parasites.

19th.—Widal positive. The fever then ran the course of typical typhoid fever.

October 19.—Fever disappeared.

23d.—Chill, followed by fever and sweat. Malarial organisms were again found in the blood. Malarial parasites preceded the fever, present at beginning, dormant during height, and then returned.

CASE II.—Four days before the patient, a healthy young man, had had a slight chill followed by fever: the next day there was a remission, but not a complete intermission. The fever then became very irregular, but did not rise above 103° F. Upon examination there was headache, constipation, enlargement of the spleen, temperature of 103° F. Blood examination showed pigmented tertian parasites within the red cells; Widal reaction absent. Quinine was given, and the fever

[1] New York Medical Journal, September 30, 1899.

dropped to not quite normal; afterwards it rose gradually and the patient developed a case of typhoid fever, from which he recovered without a return of the malarial symptoms.

In addition to the foregoing cases which we have quoted at some length, we have obtained data concerning 6 other cases of so-called mixed malarial and typhoid infection, as given in a discussion before the College of Physicians of Philadelphia February 1, 1899, concerning the experiences in the hospitals of Philadelphia with typhoid fever originating among the soldiers in the late war.

Dr. Arthur C. Meigs reported 2 cases of typhoid fever under treatment at the Pennsylvania Hospital, in which there was a return of fever after convalescence seemed to have been fully established. Examination of the blood showed the presence of the plasmodium malariæ; the variety was not stated. Recovery followed under quinine.

Dr. Alfred Stengel at the same meeting stated that he had observed 2 cases of typhoid fever in which the malarial parasite had been found during convalescence; the variety was tertian. Recovery followed.

Finally, W. H. Thompson [1] reports 2 cases of typhoid fever in which attacks of chills and fever occurred during convalescence, and in which microscopic examination of the blood showed the plasmodium malariæ; variety not stated. Patient recovered.

In the following table we have endeavored to arrange, as far as possible, all of the cases cited by us:

Mixed malarial and typhoid infection.

Date.	Author.	Number of cases.	Time of malarial attack.	Variety of parasite.	Termination.
1884	Laveran	1	During convalescence from typhoid.	Tertian	Recovery.
	do	1	Preceding the typhoid and during convalescence.	do	Do.
1890	Kinyoun	1	At commencement of the typhoid.	Not stated	Do.
	do	2	Coincident with the typhoid.	do	Death (peritonitis, pneumonia).
	do	1	During convalescence.	do	Recovery.
	do	1	Doubtful	do	Do.
1894	Thompson (W. G.).	1	Coincident	do	Do.
	do	1	During convalescence.	do	Do.
1895	Osler	1	Preceding the typhoid 6 days.	Tertian	Do.
	do	1	Preceding the typhoid 30 days.	Æstivo-autumnal	Do.
	Vincent	9	At commencement	Described as amœbic and segmenting forms and crescents.	Do.
	do	7	do	do	Death (myocarditis, nephritis, gangrene of the lung, pneumonia, abscess of the kidney and spleen, peritonitis, etc.)
	do	1	Parasites found at autopsy.	do	
1897	Da Costa	1	Not stated	Not stated	Recovery.

[1] "Acute malarial fever," New York Medical Record, December 10, 1898.

Mixed malarial and typhoid infection—Continued.

Date.	Author.	Number of cases.	Time of malarial attack.	Variety of parasite.	Termination.
1899	Lyon	1	During convalescence.	Tertian	Recovery.
			Coincident, first week.	Aestivo-autumnal	
	Curry	1	On the eighteenth day of convalescence.	Double tertian	Do
	do	5	During convalescence.	Single tertian	Do.
	do	1	do	Double tertian	Do.
	do	2	do	Double tertian; æstivo-autumnal.	Do.
	do	3	2 to 6 months after the typhoid.	Not stated	Do.
1898	Ewing	1	Immediately preceding.	Tertian	Death, fourth week (peritonitis).
	do	2	During convalescence.	do	Recovery.
	do	3	do	Not stated	Do.
1899	Craig	1	Coincident, eighteenth day.	Quartan	Death.
	Da Costa	1	Coincident, fifth day	Tertian	Recovery.
	do	1	During convalescence, twenty-eighth day.	do	Do.
	do	1	During third relapse, eighty-eighth day.	do	Do.
	do	1	During convalescence, forty-seventh day.	Not stated	Do.
	do	6	During convalescence.	Tertian or Æstivo-autumnal; generally the former.	Do.
				Variety not determined. Extracorpuscular or intracorpuscular bodies in some instances containing pigment; bodies spherical, irregular in outline, and in the intracellular variety pigment usually gathered in or near the center.	
	Muehleck	1	Coincident, second week.		Do.
	do	1	Coincident, third week.		Do.
	do	3	During convalescence, fourth week.		Do.
	do	2	Undetermined		Do.
	Withington	1	Coincident	Not stated	Death, twelfth day (perforation).
	do	2	do	Æstivo-autumnal	Recovery.
	do	7	During convalescence.	do	Do.
1898	Massachusetts general hospital.	1	Coincident	Doubtful	Do.
	do	1	During convalescence.	Tertian	Do.
	do	1	do	Æstivo-autumnal	Do.
	do	1	do	do	Doubtful.
	do	1	do	Double tertian	Recovery.
1899	Cleveland Lakeside Hospital.	1	do	Æstivo-autumnal	Death (cause not stated).
	do	1	do	do	Death (amœbic dysentery).
	do	4	do	Not stated	Recovery.
	Grandy	1	Immediately preceding and during convalescence.	Tertian	Do.
	do	1	At commencement	do	Do.
	Meigs	2	During convalescence.	Not stated	Do.
	Stengel	2	do	Tertian	Do.
	Thompson (W. H.).	2	do	Not stated	Do.

From this table we are able to make the following distribution of cases according to the time when the malarial parasite was observed in the blood; also the number of deaths:

Distribution of cases according to the time when the malarial parasite was observed in the blood; also number of deaths.

Distribution.	Number of cases.	Number of deaths.
Preceding the typhoid	3	1
Preceding the typhoid and also during the convalescence	2	0
At the commencement of the typhoid	18	7
Coincident with the typhoid	12	4
During convalescence	52	2
Two to six months after typhoid	3	0
Undetermined	4	0
At autopsy	1	1
Total	95	15

Mortality rate, 15.7 per cent.

It is a matter of considerable regret that many of the cases here given are not accompanied by anything like a complete clinical history or by detailed description of the parasite. In a majority of the cases there is a mere outline of the history. Hence, any attempt at a thorough analysis of these cases is difficult and the result perhaps misleading. We will nevertheless attempt to do so, as far as the material at our disposal will permit.

First. As to the variety of the parasite. In 51 cases this is not stated, nor does the accompanying description enable the type to be defined. Of the remaining 44 cases the variety is recorded as tertian, 22; æstivo-autumnal, 12; quartan, 1; tertian and æstivo-autumnal, 3; tertian and æstivo-autumnal, "generally the former," 6.

Second. As to time of occurrence, there are 5 cases (5.2 per cent) reported as preceding the attack of typhoid fever: Laveran, 1; Osler, 2; Ewing, 1; Grandy, 1.

In two of these cases the parasite was also found during convalescence: Laveran, 1; Grandy, 1.

The interval which preceded the observation of the malarial parasite and the onset of typhoid fever was as follows: Laveran's case, 15 days; Osler's cases, 6 and 30 days, respectively; Ewing's case, interval stated as "a few days;" Grandy's case, 15 days.

Of the 18 cases (18.9 per cent) in which the parasite is recorded as being present at the commencement of the typhoid fever, 1 case is reported by Kinyoun, 16 by Vincent, and 1 by Grandy.

In Kinyoun's case it is stated that the patient was taken sick two days before admission, the attack commencing with a chill followed by fever, and that the parasites were at this time in the blood in large numbers; six days later rose spots were seen, followed by epistaxis, etc.

In Vincent's cases nothing further is stated than that the micro-

scopic examination of the blood was made during life and at the onset of the disease ("pendant la vie et au début de l'affection").

In Grandy's case a slight chill followed by fever had occurred on the fourth day preceding the examination of the blood, an irregular fever occupying the intervening days. Upon the administration of quinine the temperature dropped, but not quite to normal.

It is worthy of observation that of the 23 cases (24.2 per cent) in which the parasite was observed within a few days preceding the attack, or at the commencement of the typhoid fever, in none of these was its presence recorded during the acute stage of the fever, and in only 2 cases during convalescence. The disappearance of the parasite was probably due in part to the administration of quinine.

In 54 cases (56.8 per cent) the presence of the parasite is recorded as occurring during convalescence from the typhoid fever; and in 2 of these cases it was also seen during the period preceding the attack.

The period during convalescence at which the parasite was found was as follows: First week, 3 cases; second week, 5; third week, 4; fourth week, 2; sixth to twelfth week, 7; undetermined, 33.

In 4 cases (4.2 per cent): Kinyoun, 1; Da Costa, 1; Muehleck, 2. The time of the observation of the presence of the parasite in the blood can not be determined.

In 1 case (1.05 per cent) reported by Vincent the parasites were found at the autopsy.

In 3 cases (3.1 per cent) reported by Curry chronic forms of the æstivo-autumnal parasite were found two to six months after the attack of typhoid fever.

In 12 cases (12.6 per cent) the parasite was found in the blood during the active stage of typhoid fever, and hence these are the only cases that properly belong under the head of coincident malarial and typhoid infection. As regards the previous history of malaria in these concurrent infections, this was positive in 1 case, negative in 3 cases, while 8 patients had been residing in malarial climates at some time shortly preceding the onset of typhoid fever (Cuba, 6; tidewater region Virginia, 2). The variety of the parasite found in these 12 cases was: Tertian, 1; quartan, 1; æstivo-autumnal, 3; undetermined, 7.

The mortality in these coincident infections was $33\frac{1}{3}$ per cent, or more than double that of the mortality given for all the cases recorded in our table, viz, 15.7 per cent. Excluding the 12 coincident infections, the remaining 83 cases give a mortality of 13.2 per cent.

We think it probable that when a larger number of cases have been reported the mortality rate will be less than here recorded. That it should exceed the average mortality of typhoid fever would not be surprising, since an individual the subject of malarial disease, even if not rendered thereby more susceptible to typhoid infection (of which there is no evidence), would probably be less able to resist the latter when once established.

When it is remembered that these 12 cases of coincident infection are all that we have been able to collect after patient search, and that a stricter criticism of each individual case would have, perhaps, reduced even this number, it will be seen that these concurrent infections are very rare and bear an extremely small proportion to the total number of typhoid cases that have been subjected to microscopic examination of the blood during the past fifteen years.

Therefore, having already conclusively shown in other parts of this report that the fever so prevalent in our military camps during the late Spanish war, and which was diagnosed by the majority of medical officers as malarial remittent or typhomalarial fever, was none other than typhoid fever, it would not be profitable to here further discuss the nature of typhomalarial fever, especially in view of the results obtained by a careful study of all the cases of so-called mixed malarial and typhoid infection recorded in the literature.

It will suffice to state that while the opinion expressed by Woodward, namely, that the poison of malaria and of typhoid fever could be present in the body at the same time, is shown to be well founded, his contention that the two poisons could give rise to a "hybrid form of disease, exhibiting the ordinary symptoms of malarial and typhoid fever variously combined," is not borne out by observation.

Further, that Woodward's opinion concerning the frequency of the association of the two poisons so that "there was danger that this hybrid form would appear in epidemic proportions whenever an army recruited in a nonmalarial region should campaign on malarial soil" is proven to be absolutely without foundation.

Rather do the observations which we have brought together appear to indicate that when an individual the subject of malaria is subsequently infected by the typhoid bacillus, the manifestations of the malarial parasite remain, as a rule, in abeyance during the active stage of the typhoid infection, to reappear in a certain proportion of cases during the stage of debility attendant upon convalescence.

It follows that the term "typhomalarial" as applied to a particular type of fever, whether used in the sense understood by Woodward or as indicating a severe type of malarial disease, is equally misleading and should be dropped from the nomenclature.

CHAPTER XIV.

GENERAL STATEMENTS AND CONCLUSIONS.

(*1*) *During the Spanish war of 1898 every regiment constituting the First, Second, Third, Fourth, Fifth, and Seventh Army Corps developed typhoid fever.*

This is true of both the volunteer and the regular commands. We are aware of the fact that several regiments have claimed freedom from typhoid fever, and it is true that the sick records of more than

one command failed to show any evidence of this disease; but by carefully tracing the sick to hospitals we have been able to find one or more cases of typhoid fever in every regiment.

(2) *More than 90 per cent of the volunteer regiments developed typhoid fever within eight weeks after going into camp.*

The following table gives for 106 regiments, in which these data were ascertained, the time of assembly at the State encampment, the date of muster into the United States service, the date of arrival at national encampments, and the date of appearance of the first case of "probable" and of "recognized" typhoid fever.

Regiments.	Assembled at State encampment.	Mustered into United States service.	Arrived at national encampment.	Date of first case of probable typhoid.	Date of first case of recognized typhoid.
FIRST ARMY CORPS.					
FIRST DIVISION.					
1st Kentucky	Last May	June 5	June 11	June 19	June 20
3d Wisconsin	Last April	May 8	May 15	May 24	May 28
5th Illinois	Apr. 26	May 7	May 17	May 16	May 16
4th Ohio	In April	May 9	May 16	May 17	July 16
3d Illinois	do	May 7	May 17	do	June 28
4th Pennsylvania	do	May 10	May 16	June 1	June 1
16th Pennsylvania	do	May 11	May 17	May 8	May 20
2d Wisconsin	Apr. 28	May 12	do	May 11	June 16
3d Kentucky	In May	May 21	June 2	June 9	June 21
SECOND DIVISION.					
31st Michigan	In April	May 6	May 17	June 1	June 1
160th Indiana	do	[1] May 8	do	July 4	July 7
1st Georgia	In May	In May	June 17	June 6	June 6
158th Indiana	In April	May 12	May 16	do	June 24
6th Ohio	Apr. 25	do	May 18	May 18	May 18
1st West Virginia	In April	May 10	May 20	June 6	June 16
1st Pennsylvania	Apr. 28	May 11	May 18	May 12	May 12
14th Minnesota	In April	May 10	do	May 27	June 3
2d Ohio	do	do	do	May 20	June 22
THIRD DIVISION.					
5th Pennsylvania	Apr. 27	May 11	May 20	May 19	May 19
12th Minnesota	Apr. 29	May 7	do	May 20	June 21
8th Massachusetts	May 5	May 8	do	May 28	July 24
21st Kansas	In April	May 10	do	May 21	May 21
12th New York	May 2	do	do	June 6	July 3
2d Missouri	May 5	do	do	May 26	May 27
1st New Hampshire	In April	May 12	May 22	May 24	June 4
9th Pennsylvania	do	May 10	May 20	May 31	June 14
THIRD ARMY CORPS.					
FIRST DIVISION.					
14th New York	In April	May 13	May 20	May 23	June 12
1st Missouri	do	do	May 21	May 31	June 28
5th Maryland	do	May 10	do	June 25	June 25
2d Nebraska	Apr. 27	do	May 22	May 26	June 3
2d New York	In April	May 8	May 21	June 1	June 11
3d Tennessee	do	May 5	May 24	June 9	June 26
1st Vermont	Apr. 1	May 16	do	May 26	Do.
8th New York	In April	May 21	May 25	June 24	June 24
SECOND DIVISION.					
2d Kentucky	In April	May 22	May 26	June 26	June 26
9th New York	May 2	May 10	do	June 10	June 13
1st Arkansas	In April	May 19	May 27	June 2	June 3
5th Missouri	do	May 18	do	June 6	July 2
2d Arkansas	In May	May 27	May 30	June 4	June 15
69th New York	In April	May 6	May 27	June 12	June 23
1st Maine	do	May 13	May 30	June 25	June 27
52d Iowa	Apr. 26	May 25	May 31	June 8	June 8
1st Mississippi	In May	May 26	do	June 1	June 1

Regiments.	Assembled at State encampment.	Mustered into United States service.	Arrived at national encampment.	Date of first case of probable typhoid.	Date of first case of recognized typhoid.
SECOND ARMY CORPS					
FIRST DIVISION.					
(Camp Alger, Va.)					
65th New York	May 2	May 17	May 20	May 18	May 18
7th Ohio	End April	May 11	May 21	May 14	May 14
1st New Jersey	do	May 5	do	July 2	July 2
8th Pennsylvania	do	May 11	May 18	May 15	May 15
12th Pennsylvania	do	do	May 19	June 26	June 26
13th Pennsylvania	do	May 12	do	June 16	June 16
6th Illinois	do	May 11	May 21	May 15	May 15
6th Massachusetts	do	May 12	May 22	June 2	June 2
8th Ohio	do	May 13	May 19	July 12	July 12
3d Virginia	do	do	June 5	June 6	June 6
1st Connecticut	May	May 17	July 19	Aug. 5	Aug. 5
A and C, New York Cavalry	do	May 20	May 23	May 30	May 30
SECOND DIVISION.					
(Camp Alger, Va.)					
22d Kansas	End April	May 11	May 28	July 27	June 21
159th Indiana	do	May 12	May 24	June 14	June 14
3d New York	May	May 17	May 29	June 18	June 18
7th Illinois	do	May 18	June 3	July 10	July 10
6th Pennsylvania	End April	May 10	May 19	May 29	May 29
4th Missouri	May	May 16	May 27	June 12	June 12
9th Ohio Battalion	do	May 14	May 20	July 19	July 19
3d Missouri	do	do	May 30	June 30	June 20
1st Rhode Island	End April	May 10	May 28	July 12	July 12
2d Tennessee	do	May 7	May 29	May 29	May 29
FIRST DIVISION.					
(Camp Meade, Pa.)					
1st Maryland	Apr. 25	May 16	May 25	Aug. 2	July 30
35th Michigan	July 10	July 9	Sept. 16	do	July 28
10th Ohio	July 5	July 1	Aug. 19	July 16	July 16
3d Connecticut	June 23	July 2	Sept. 10	Aug. 14	Aug. 22
202d New York	July 20	July 19	Sept. 14	Aug. 30	Aug. 28
15th Minnesota	July 5	July 9	Sept. 18	Aug. 3	July 20
SECOND DIVISION.					
(Camp Meade, Pa.)					
4th New Jersey	July 19	July 7	Oct. 9	Aug. 2	Sept. 7
205d New York	July 10	July 15	Sept. 12	July 27	Aug. 4
2d West Virginia	June 23	June 25	Aug. 30	July 10	July 5
5th Massachusetts	June 10	June 30	Sept. 12	Aug. 2	Aug. 2
201st New York	July 4	July 16	Sept. 9	Aug. 20	Aug. 4
1st Delaware	Apr. 26	May 9	Aug. 20	May 21	July 27
2d Pennsylvania	April	May 10	May 19	May 26	Aug. 2
FOURTH ARMY CORPS.					
1st Ohio	End April	May 6	May 16	June 1	July 22
157th Indiana	do	May 10	May 17	June 10	June 18
32d Michigan	do	May 11	May 22	July 5	July 5
2d Georgia	do	do	May 21	May 20	June 8
5th Ohio	do	do	do	May 21	May 21
FIRST DIVISION.					
1st Alabama	do	May 9	June 21	May	May.
2d Alabama	May	May 16	June 30	June	June.
1st Louisiana	End April	May 8	June 23	June 15	June 15
2d Louisiana	do	May 11	June 29	May	May.
1st Texas	do	May 10	do	June	June.
2d Texas	do	May 11	June 28	do	Do.
1st South Carolina	May	May 10	June 7	May	Do.
SECOND DIVISION.					
2d Illinois	Apr. 26	May 16	May 23	May 25	May 29
1st North Carolina	May 1	May 3	do	June 6	June 27
2d New Jersey	Apr. 27	May 13	June 3	June 29	July 3
1st Wisconsin	Apr. 28	May 14	May 24	June 21	May 14

[1] About.

Regiments.	Assembled at State encampment.	Mustered into United States service.	Arrived at national encampment.	Date of first case of probable typhoid.	Date of first case of recognized typhoid.
FOURTH ARMY CORPS—Continued.					
SECOND DIVISION—continued.					
50th Iowa	Apr. 26	May 17	May 25	June 20	June 16
9th Illinois	June 27	July 4	Aug. 8	July 21	July 6
2d Virginia	May 10	May 11	June 3	June 2	June 8
4th Virginia	May 9	May 9	June 7	June 11	Do.
49th Iowa	Apr. 26	June 2	June 14	June 14	July 22
THIRD DIVISION.					
4th Illinois	May	May 19	May 29	July 11	July 11
161st Indiana	June	July 11	Aug 14	July 16	July 16
2d Mississippi	May	May 20	June 21	June 8	June 8
6th Missouri	June	July 30	Aug. 15	Aug. 1	Aug. 1
3d Nebraska	do	July 1	July 22	July 26	July 26
2d South Carolina	May	May 14	Sept. 16	June 20	June 20
2d U. S. Volunteer Cavalry	April	May 1	June 28	July 30	July 30

The foregoing table may be briefly summarized as follows:

	Number of regiments which came to national encampments with typhoid fever.	Number of regiments which developed typhoid fever after arrival at national encampments in—			
		2 weeks.	3 weeks.	4 weeks.	Over 4 weeks.
Number of regiments with recognized cases of typhoid fever	35	18	13	8	32
Number of regiments with "recognized and probable" cases of typhoid fever	41	30	15	5	15

It will be seen that we have obtained the initial dates of the first cases of "probable" and of "recognized" typhoid fever in 106 regiments. If we suppose that the cases of recognized typhoid fever were actually the first cases of the disease, then the following statements are correct:

(*a*) Thirty-five regiments, or 33.01 per cent, reached the national encampments with developed cases of recognized typhoid fever.

(*b*) Eighteen regiments developed recognized typhoid fever within 14 days after arriving at national encampments, thus making 53 regiments, or 50 per cent, with recognized typhoid fever within 14 days after reaching national encampments.

(*c*) Thirteen additional regiments developed recognized typhoid fever within 21 days after reaching national encampments. Thus, 3 weeks after arriving at the national encampments 66, or 62.26 per cent, out of the 106 regiments had cases of recognized typhoid fever.

(*d*) Eight additional regiments developed recognized typhoid fever within 28 days after reaching national encampments, thus making the total number of regiments with recognized typhoid fever 28 days after arrival 74, or 69.81 per cent.

If our claim be accepted that the cases designated as probable typhoid fever were really due to this disease, the following conclusions may be drawn:

(*a*) Forty-one, or 38.67 per cent, reached the national encampments with cases of typhoid fever already developed:

First Army Corps, Chickamauga Park.

5th Illinois.
3d Illinois.
16th Pennsylvania.
2d Wisconsin.
6th Ohio.
1st Pennsylvania.
5th Pennsylvania.
12th Minnesota.
1st Georgia.

Second Army Corps, Camp Alger, Va.

65th New York.
7th Ohio.
6th Illinois.
2d Tennessee.
8th Pennsylvania.

Second Army Corps, Camp Meade, Pa.

35th Michigan.
10th Ohio.
3d Connecticut.
202d New York.
15th Minnesota.
203d New York.
2d West Virginia.
5th Massachusetts.
201st New York.
1st Delaware.
4th New Jersey.

Fourth Army Corps, Mobile, Ala., etc.

2d Georgia.
5th Ohio.

Seventh Army Corps, Jacksonville, Fla.

9th Illinois.
2d Virginia.
49th Iowa.
1st Alabama.
2d Alabama.
1st Louisiana.
2d Louisiana.
1st Texas.
2d Texas.
1st South Carolina.
161st Indiana.
2d Mississippi.
6th Missouri.
2d South Carolina.

(*b*) Thirty additional regiments developed typhoid fever within 14 days after reaching the national encampments. In other words, 71, or 66.98 per cent, of the 106 regiments had developed typhoid fever within 14 days after reaching the national encampments.

(*c*) Eighty-six, or 82.26 per cent, of the 106 regiments had developed typhoid fever within 3 weeks after arriving at the national encampments.

(*d*) Five additional regiments developed typhoid fever within 28 days after reaching national encampments, thus making the total number of regiments with typhoid fever 28 days after arrival 91, or 85.84 per cent.

(*e*) Thirteen additional regiments developed typhoid fever within 8 weeks (viz, 5 in 5 weeks, 3 in 6 weeks, 4 in 7 weeks, and 1 in 8 weeks) after reaching the national encampments, thus making the total number of regiments with typhoid 8 weeks after arrival 104, or 98.11 per cent.

Of the remaining 2 regiments, 1, the Ninth Ohio Battalion, developed typhoid fever in 9 weeks, and 1, the First Maryland, in 10 weeks after arrival at national encampments.

We have been compelled to satisfy ourselves with a general statement that many of the regiments assembled at State encampments in April. In fact, this general statement must suffice, because no one day can be given as the day of assembly. Some companies reached the State encampment a few days earlier or later than others. However, as the first call for troops was issued April 20, 1898, it must follow that all regiments which assembled at State encampments in the month of April did so during the last week of that month. Bearing this in mind, and accepting our cases of probable typhoid as the first cases of this disease, it will be seen by an inspection of the table given that of the 106 regiments for which we have the data bearing upon this subject 97, or 91.52 per cent, developed typhoid fever within 8 weeks after assembling at the State encampment.

(*3*) *Typhoid fever developed also in certain of the regular regiments within three* (*3*) *to five* (*5*) *weeks after going into camp.*

When war with Spain was proclaimed the total strength of the standing Army of the United States numbered 27,000 officers and men. They were scattered at about 100 military garrisons. All of these soldiers were well housed and their quarters were, from a sanitary standpoint, in good condition. At most of the garrisons, at least the water supply was above suspicion, and the disposal of waste was such as not to endanger health or the life of the soldier. There was no epidemic at any post, and the army was reasonably free from infectious disease, except those of venereal origin. The number of cases of typhoid fever among the 27,000 officers and men during the first four months of 1898 was distributed as follows: In January, 9 cases, with 1 death; in February, 3 cases, with 1 death; in March, 4 cases, with no deaths; in April, 6 cases, with 1 death. During the last week in April and the first week of May, 1898, the regular regiments were assembled at national encampments and placed under canvas. These regiments were receiving recruits in considerable numbers from the larger centers of population.

The following table shows the dates of going into encampment and the appearance of first cases of recognized typhoid fever in those regular regiments for which we have been able to obtain desired data.

Command.	Date of going into encampment.	Date of first case of recognized typhoid fever.
2d U. S. Infantry	Apr. 22, 1898	May 28, 1898
4th U. S. Infantry	do	May 18, 1898
6th U. S. Infantry	do	May 19, 1898
7th U. S. Infantry	Apr. 24, 1898	May 26, 1898
13th U. S. Infantry	Apr. 23, 1898	May 8, 1898
16th U. S. Infantry	Apr. 22, 1898	May 20, 1898
22d U. S. Infantry	do	May 29, 1898
24th U. S. Infantry (colored)	Apr. 20, 1898	May 28, 1898
25th U. S. Infantry (colored)	do	do

(*4*) *Typhoid fever became epidemic both in the small encampments of not more than one regiment and in the larger ones consisting of one or more corps.*

The statement has been made that the epidemics of typhoid fever in our national encampments in 1898 were due to crowding together large numbers of men. We have seen that the Third North Carolina, at its isolated post at Fort Macon, N. C., developed typhoid fever before it was sent to Knoxville, where it became a part of the Second Division of the First Army Corps.

When we reached Knoxville, Tenn., in our round of inspecting the troops, we were informed that the Fourth Tennessee was encamped near Knoxville, where it had been since mobilization, and that it was wholly free from typhoid fever. A personal investigation showed the following facts: This regiment assembled at the camp near Knoxville, Tenn., June 28, 1898, although it was not mustered into the United States service until about the middle of July. On August 12 Ernest Martin, who had not been well for a week preceding this time, was admitted to the regimental hospital. On August 15 he was furloughed home, and on September 11 he died at his home in Nashville, Tenn., of typhoid fever. From the date of this first case up to the time of our inspection (September 14, 1898) there had been in this regiment not less than 11 well-marked cases of typhoid fever, although none had been so diagnosed by the regimental surgeon.

The Fifteenth Minnesota, at its regimental encampment on the fair grounds at St. Paul, Minn., and the Thirty-fifth Michigan, at Island Lake, Michigan, developed epidemics of typhoid fever. Other instances might be cited, but these suffice to show the truth of the statement that the disease became epidemic in small as well as in large encampments.

(*5*) *Typhoid fever became epidemic in camps located in the Northern as well as in those located in the Southern States.*

Some Army medical officers have placed stress upon the fact that Northern men were transferred to Southern States, and have attributed considerable importance to the influence of nonacclimatization in the production of the epidemics of typhoid fever. In answer to this we need only call attention to the fact that the Fifteenth Minnesota, Thirty-fifth Michigan, and the Two hundred and third New

York surpassed any other three regiments in the number of cases of typhoid fever before they crossed the Mason and Dixon line. There is nothing more certain than that the prevalence of typhoid fever among the troops in 1898 was not due to geographical location.

(*6*) *Typhoid fever is so widely distributed in this country that one or more cases are likely to appear in any regiment within eight weeks after assembly.*

We have no reliable data concerning the extent to which typhoid fever prevails in this country, but from the number of deaths from this disease we can fairly estimate the number of cases. The following figures may give us some idea as to the chances of infected men being found in each volunteer regiment. In making this calculation we will figure on the number of cases of typhoid fever in New York City. This place is selected because it is not subject to epidemics of typhoid fever and, in fact, is believed to be unusually free from that disease. In 1897 there were 299 deaths from typhoid fever reported in New York City. Supposing that typhoid fever is no more deadly in New York City than it is in Hamburg—and there is no reason for believing that it is—then 299 (the number of deaths from typhoid fever) is about 7.5 per cent of the total number of cases of typhoid fever that occurred in New York City in the year given. On making this computation we find that there were in New York City in 1897, 3,853 cases of typhoid fever. It is safe to say that at least four-fifths of the cases of typhoid fever occur in individuals of the military age (between 18 and 45 years). This means that in 1897 there were in New York City 3,082 cases of typhoid fever among those inhabitants who were from 18 to 45 years of age. The Government census for 1890 places the population of New York City at that time at 1,515,301. A police census, made in April, 1895, indicated a population of 1,849,866. We will be liberal in our calculations and suppose that the population of New York City in 1897 was 2,000,000. In round numbers the number of people between 18 and 45 years of age is one-half the total population. On this basis the number of people of military age in New York City in 1897 may be placed at 1,000,000. (This of course includes both males and females.) Had this 1,000,000 of people of military age been divided into regiments of 1,300 each they would have furnished 769 commands. We have seen that the number of cases of typhoid fever in New York City in 1897 among people of military age was 3,082, and if these had been evenly divided among the regiments of 1,300, each command would have contained at least 4 persons who would develop typhoid fever during the year. We make no claim that the above given figures are accurate. We have presented them simply for the purpose of showing the chances of there being men infected with typhoid fever in every regiment of volunteers. We think that it must be admitted that there is not much difficulty in accounting for the origin of typhoid fever in our national encampments. With this

disease as prevalent as it is throughout the country, it is more than probable that in any organization of 1,300 men of military age taken from private life and held together for two months one or more cases will develop.

(7) *Typhoid fever usually appears in military expeditions within eight weeks after assembly.*

The following quotations taken from a paper on "Enteric fever in campaigns," by Surgeon-Captain Davies, assistant professor of hygiene at the English Army Medical School, illustrate the above statement:

In the Galeaka-Gaika war in South Africa the troops crossed the river Kei in December, 1877, in the hot and dry season. Diarrhea and simple continued fever soon became prevalent, but the general health was good. In the middle of January, 1878, heavy rains came on. In February, sickness increased, consisting principally of diarrhea, dysentery, and "common continued fever." Bowel complaints toward the end of March, but as the cold season came on, enteric fever, at first mild and insidious, occurred throughout the country, and in May it is reported that no place was free from it.

In the Zulu war, which commenced at the end of December, 1878, fever appeared at the headquarters of Helpmakaar, and at Rorkes Drift in the middle of February, accompanied by diarrhea and dysentery; the fever was thought to be "bilious remittent," "enteric," or a mixture of both. Helpmakaar became so unhealthy that the troops had to be moved to Utrecht and Dundee. Epidemics of enteric fever immediately broke out at both of these places.

In the Afghan campaign of 1878–1880 it is noted that cases occurred at almost all the stations occupied by European troops, stretching from the Indian frontier to Kabul and Kandahar. Some of these posts had probably never been occupied before, and many of these cases were quite isolated.

In the Egyptian expedition of 1882 there was great prevalence of bowel complaints from the first landing of the troops in the latter part of July—diarrhea, dysentery, and fever. Enteric fever occurred very soon, both at Alexandria and at Ismailia. When the troops arrived at Cairo the disease increased gradually, but did not reach any great prevalence until October and November. During October, November, and December, out of a total of 319 deaths, no less than 223 were due to enteric fever.

In the Nile campaign, in 1884–85, a great number of isolated posts were occupied, extending over a large tract of country. Enteric fever occurred at all or nearly all of these posts, most severely at Assuan and Wady Halfa.

During the French operations in Tunis in 1881 the disease was extremely prevalent, about one-fifth of the whole force being attacked. It has been stated that all the columns on the march and nearly every occupied post were attacked more or less. In some instances bodies of troops suffered from the disease who had not been in contact with other (infected) troops, and who had not occupied any old (infected) encampments.

We have brought in these quotations in order to show that typhoid fever generally, most probably universally, appears in military expeditions. Similar experiences are recorded in the histories of mining camps.

(8) *The miasmatic theory of the origin of typhoid fever is not supported by our investigations.*

There are still a few who believe that typhoid fever is due to a poison or miasm given off from the earth in gaseous form. We would not

mention this obsolete theory were it not for the fact that while inspecting the camps we found intelligent medical officers who believed that some intangible local condition inherent in the place was an important factor in the production of the epidemic. There is apparent in man a tendency to believe in the evil genius of locality. He is prone to attribute many of his misfortunes to indefinable conditions surrounding the place in which he has suffered. As we have stated, no fact in our investigations has been brought out more prominently than the demonstration that locality was not responsible for the epidemic. The Fifteenth Minnesota first developed typhoid fever at the fair grounds at St. Paul. There is certainly no evidence that there is any evil climatic influence connected with this place. It carried the epidemic with it to Fort Snelling, which has long had the reputation of being one of the most healthful army posts in the United States. From Fort Snelling the Fifteenth Minnesota was transferred to the open fields of Camp Meade, where generations of Pennsylvania farmers have passed the average number of years allotted to man without suspecting that their country was an unhealthy one. However, typhoid fever continued with the command from Minnesota because the men carried the germs of the disease in their bodies, clothing, bedding, and tentage. Certainly, any rational being would prefer any of the above-mentioned localities to Port Tampa as a place of summer residence, and yet there was not a regiment in the Fourth Army Corps, encamped for so long a time in Florida, that had as many cases of typhoid fever as did the Fifteenth Minnesota.

(*9*) *The pythogenic theory of the origin of typhoid fever is not supported by our investigations.*

Murchison proposed this theory of the origin of typhoid fever. This author states the theory in the following words:

> Typhoid fever may be generated independently of a previous case by fermentation of fecal, and perhaps other forms of organic matter.

Translated into the terms of modern medicine, this theory is founded upon the belief that the colon germ may undergo a ripening process by means of which its virulence is so increased and altered that it may be converted into the typhoid bacillus, or at least may become the active agent in the causation of typhoid fever. Many French, English and American army medical officers believe that typhoid fever may originate in this way. Rodet and Roux, of the French army, have stated their belief that outside of the body the colon bacillus acquires "typhogenic" properties. Surgeon-Captain Davies, assistant professor of hygiene in the English Army Medical School, has expressed his belief in this theory. Some of the medical officers in the American Army have also given it their adherence. Surgeon Davies gives the following statement of the reasons for his belief in this theory:

> It is well known that "camp diarrhea" is of the commonest occurrence among troops shortly after taking the field in a tropical or sub-tropical climate. Change

of habits, change of food, improper or unsuitable food, bad water, heat, and exposure to sun and chill—these are all obvious factors in its causation; there is nothing in any way specific. Let us consider the sequel as regards the individual and as regards his surroundings. The individual may in some cases remain in fairly good health and vigor, in spite of a continuance of the bowel trouble; other individuals may suffer more from the exposure, fatigue, and weakening effects of the continued flux. The surroundings may possibly be and remain sanitary, the camp clean, the water pure; but in all probability the reverse will be the case—at any rate, in some instances—the water bad, the soil fouled, very likely overcrowding of the camp, with consequent difficulty, if not impossibility, of proper removal or disposal of fecal matters. Under certain conditions of heat and moisture favorable to the development and multiplication of low forms of vegetable and animal life which is the more likely or reasonable to expect, that diarrhea in weakly and exhausted individuals should remain diarrhea and nothing more, or that with an increase of filth and decomposition, polluting soil, air, and water, a development of filth-generated, pythogenic poison should take place, capable of causing in such weakly persons a fever, with diarrhea, a poisoning of the organism, producing pyrexia and inflammation of certain glands in the alimentary tract—in fact, a specific fever? Is this supposition of the evolution, gradual or rapid according to circumstances, of a disease poison dependent on increasing conditions of pollution of soil, air, or water, either separately or all three together, unreasonable or illogical? Would it not, on the contrary, be more unreasonable to suppose that, under such conditions, there should be no evolution at all? These conditions of camp pollution undoubtedly exist and tend to increase in many instances. Are they to have no effect? Is diarrhea to continue as simple diarrhea, or is evolution to come into action and produce a new disease? New, indeed, only because the causes necessary for its production are just now brought into action—spontaneously only in the sense that water is of spontaneous origin, when from hydrogen and oxygen the electric spark has produced water where no water was before."

We believe that the results of our investigations controvert this theory conclusively. In the first place, we have been able to show that the specific poison of typhoid fever was introduced into every one of our national encampments, and with the disease as widespread as it is in this country, we believe that we have good reasons for the claim that one or more men already specifically infected with typhoid fever enlisted in nearly every command. There is, therefore, no necessity of resorting to the theory that the colon bacillus may be converted into the typhoid bacillus. Moreover, all the known facts of experimental bacteriology are at variance with this theory. The supposition that simple diarrheas may develop into typhoid fever will be again referred to.

(*10*) *Our investigations confirm the doctrine of the specific origin of typhoid fever.*

As has already been stated, we have been able to trace the introduction of typhoid fever into every one of our national encampments and into the majority of the regiments. In case of the few commands about which there is some uncertainty as to the men bringing the typhoid infection from their homes, we may state that in all of these there was ample opportunity for the introduction of the specific poison from other commands.

(*11*) *With typhoid fever as widely disseminated as it is in this country the chances are that if a regiment of 1,300 men should be assembled in any section and kept in a camp, the sanitary conditions of which were perfect, 1 or more cases of typhoid fever would develop.*

We have already stated our reasons for our belief in the above-given proposition. In such a camp, however, the disease would not become epidemic and ultimately it should disappear altogether.

(*12*) *Typhoid fever is disseminated by the transference of the excretions of an infected individual to the alimentary canals of others.*

It is more than probable that many individuals may for a while carry and eliminate the specific bacillus of typhoid fever without developing the disease themselves. Later we will make statements concerning the probable proportion of men who are immune to this disease. In discussing the etiology of typhoid fever we have seen that persons who have recovered from this disease may for a long time continue to carry and excrete the specific poison. We have also shown that the longevity of the Eberth bacillus outside of the body under certain conditions is much greater than is generally supposed. The agents by which the specific germ of typhoid fever may be disseminated have been enumerated and quite fully discussed in the chapter on etiology.

(*13*) *Typhoid fever is more likely to become epidemic in camps than in civil life because of the greater difficulty of disposing of the excretions from the human body.*

This proposition is so self-evident that it needs no lengthy argument to support it. The influence of the introduction of sewers into cities in decreasing sickness from this disease is well known to every student of sanitary science. Moreover, since the disease is disseminated by the transference of the excretions of an infected individual to the alimentary canal of others, it must follow that the more thoroughly and completely the excretions are removed from the vicinity of habitations the less will be the danger of infecting the inhabitants. In fact, the whole question of the prevention of typhoid fever in armies is largely one of the disposition of the excretions. Later we will give figures to show that the prevalence of typhoid fever in certain camps was in an inverse direct proportion to the thoroughness with which the excretions were removed from the vicinity of the camps.

(*14*) *A man infected with typhoid fever may scatter the infection in every latrine in a regiment before the disease is recognized in himself.*

The elimination of typhoid bacilli from the bowels probably begins soon after infection. If this be true, during the entire period of incubation an individual may be a source of danger to others. Moreover, in most instances of typhoid fever the disease is not recognized during the prodromal stage, and during this time the excretions may be laden with typhoid bacilli. It must be evident from this that the only way in which typhoid epidemics can be with certainty prevented in armies

is by the complete disinfection of the stools of all, both the sick and the well.

(*15*) *Camp pollution was the greatest sin committed by the troops in 1898.*

In our histories of the different regiments we have had too frequent opportunity to call attention to the fearful pollution that existed in many camps. As we have already stated, fecal matter was deposited on the surface about the camps at Chickamauga. Much of this filth must have been specifically infected with typhoid fever. Sinks were frequently overflowed by heavy rains, and their contents were distributed on the adjoining surface. It is needless to dwell upon this point and we may refer those who desire particulars to the regimental histories that have already been given.

(*16*) *Some commands were unwisely located.*

While there is no evidence that any of the places selected for national encampments were called unhealthful, it is true that some of them were not suited for camp sites. It is quite impossible to keep camps in a sanitary condition at a location such as that for a while occupied by one brigade of the Fourth Army Corps near Port Tampa, Fla. On account of the nature of the ground and the surroundings, Palmetto Beach was certainly a very unsuitable location for a permanent camp. Every medical officer in the First Division of the Seventh Army Corps condemned Miami, and this condemnation was approved by officers both of the staff and of the line who visited this encampment. The men could not be made comfortable at this place. Notwithstanding these facts there were regiments at Chickamauga that had more cases of typhoid fever than did any of them in the division at Miami, but this is no reason why the troops at the latter place should have been so uncomfortably situated. Some commands were unwisely located for the simple reason that the soldiers could not be comfortably accommodated at the places named. There was, however, a much more serious defect in the location of certain commands. Some regiments at Chickamauga, as we have shown, were so located that they received the drainage of other regimental camps. There was certainly no sufficient excuse for this.

(*17*) *In some instances the space allotted the regiments was inadequate.*

This was true of more than one command at Chickamauga. For instance, the One hundred and fifty-eighth Indiana was forced to contract its lines to half the regulation distance, and then it was only 30 feet distant from the Sixth Ohio. The sinks of the last-mentioned regiment and the kitchens of the First West Virginia were only 12 or 15 feet apart. At Camp Alger the Eighth, Twelfth, and Thirteenth Pennsylvania were packed closely together, with scarcely an interval between the regiments; tents of the same companies in contact with each other on the sides, and of adjacent companies in contact by the

ends. We are forced to conclude from this and numerous other similar examples that there were line officers whose efficiency might have been enhanced by some knowledge of camp hygiene.

(*18*) *Many commands were allowed to remain on one site too long.*

There were regiments at Chickamauga that did not move a tent from the time of arrival in May to that of departure late in August.

(*19*) *Requests for change in location made by medical officers were not always granted.*

As an illustration under this head we may call attention to the official records of the Fifth Pennsylvania. This command reached Chickamauga Park May 20, and it was unfortunately located on low ground. Requests for a change in location were repeatedly sent in during June and July. The soil became muddy, the camp received the washings from other camps above, the sinks rapidly filled with water and overflowed, and still requests for change in location were unheeded until August 12, when the regiment was allowed to occupy a new camp two miles to the west and on a higher piece of ground.

(*20*) *Superior line officers can not be held altogether blameless for the unsanitary condition of the camps.*

As we have already seen, some of the regiments were improperly located from a sanitary standpoint. This was done by superior line officers, and sometimes in the face of protests from the medical officers. We have also seen that requests for change in location were disregarded, and regiments were allowed to occupy one site for too long a time. In general, the camps became very filthy. It must therefore be admitted, it appears to us, that line officers were to some extent responsible for the condition of the camps under their command. The medical officer can only recommend; the line officer can command. We think it unfortunate that hygiene is not taught in our national military school. It does seem that line officers should be able to recognize the importance of reasonable requests and recommendations made by the medical officers.

(*21*) *Greater authority should be given medical officers in questions relating to the hygiene of camps.*

In our opinion it is of the greatest importance that more authority be granted medical officers in all matters pertaining to the hygiene of camps.

(*22*) *It may be stated in a general way that the number of cases of typhoid fever in the different camps varied with the methods of disposing of the excretions.*

This is well illustrated by the methods of disposing of fecal matter and the number of cases of typhoid fever in the three divisions of the Seventh Army Corps. The First Division was most uncomfortably located at Miami, Fla., from the last week in June until the second week in August. On the last-mentioned date it was removed to Jackson-

ville, where it joined the other divisions. During a part of its stay at Miami, and during the entire period of its encampment at Jacksonville, water carriage was employed for the disposition of fecal matter. The number of cases of probable typhoid fever that developed in the six regiments of this division was 1,030. In the Second Division the tub system of disposing of fecal matter was employed. By this method infected fecal matter was scattered all through the camp. The number of cases of probable typhoid fever that developed in nine regiments of this division was 2,693. In the Third Division regulation pits were used for the disposal of fecal matter. The number of cases of probable typhoid fever that developed in seven regiments of this division was 1,292.

(*23*) *The tub system of disposal of fecal matter as practiced in the Second Division of the Seventh Army Corps is to be condemned.*

Of all the methods used for the disposal of fecal matter practiced in the national encampments in 1898, this we regard as the most unsatisfactory. The reason for our condemnation of this system has already been given.

(*24*) *The regulation pit system is not a satisfactory method of disposing of fecal matter in permanent camps.*

Especially is this true in tropical countries, and in temperate climates during the summer time. It is a very difficult thing to have the soldiers appreciate the necessity of keeping fecal matter covered. As we have elsewhere stated, in many camps orders were issued requiring each man to cover his feces as soon as deposited; but we did not inspect the pits of a regiment in which we did not find exposed fecal matter. Moreover, in our camps in 1898 flies swarmed so numerously that the first droppings of fecal matter were often covered with them before the act of defecation was completed. The pit system may be employed when armies are on the march and stopping at one place for a few days at most, but even then they are sources of danger, and we believe that it is quite impossible to wholly prevent the spread of typhoid fever in camps in which this method of disposing of fecal matter is employed. We have seen how difficult it was to prepare sinks of proper dimensions at Chickamauga, and, furthermore, that it was quite impossible to keep the contents of these sinks properly covered. The clay thrown out in digging the pits hardened in the sun and when thrown back into the pit on the fecal matter had but little absorptive power, and the result was that fecal matter was constantly exposed. We have also seen that in some of the camps about Tampa it was impossible to dig sinks on account of the height of the ground water. For these reasons we are thoroughly convinced that if epidemics of typhoid fever are to be prevented some other method of disposing of fecal matter in camps occupied for a week or longer must be resorted to.

(*25*) *In permanent camps where water carriage can not be secured*

all fecal matter should be disinfected and then carted away from the camp.

For this purpose we have made a special recommendation that galvanized-iron troughs containing milk of lime be used for the reception of all fecal matter and urine, and that the contents of these troughs be removed daily by means of the portable odorless excavator. We are aware of the fact that this method of disposing of fecal matter will be attended by increased cost, but we are confident that it will lessen greatly the number of cases of typhoid fever. We believe that there is no question pertaining to army hygiene of more importance than that relating to the method of disposing of fecal matter and urine. The way in which this is done will largely determine the number of cases of typhoid fever that will develop in any command. We feel, therefore, that we can not be too urgent in our recommendation of the abolition of former methods of disposing of fecal matter and the adoption of some other system of disinfecting all excreta. This system has been adopted by the War Department, and a full description published in General Orders, No. 170, Adjutant-General's Office, Washington, September 26, 1899.

(*26*) *Infected water was not an important factor in the spread of typhoid fever in the national encampments in 1898.*

There were probably local water supplies that became specifically infected with the typhoid fever bacillus, but infected water was not the great factor in the causation of this disease. It is possible that the piped water at Chickamauga became specifically contaminated. Certainly, the location of the intake pipe in Chickamauga Creek so near the junction of that stream with the Cave Spring Branch which drained many of the camps was not justifiable, and it hardly seems possible that the piped water wholly escaped contamination. However, that even at Chickamauga infected water was not the chief factor in the spread of typhoid fever is shown by the fact that regiments which did not drink piped water also became widely infected with the disease, and it is furthermore demonstrated by the fact that the spread of typhoid fever continued after the regiments had been moved to Knoxville, Tenn., and Lexington, Ky., at both of which places the water supply was above suspicion. It is also probable that some of the local water supplies at Chickamauga became specifically contaminated. This might have been true of the wells from which the regiments of the Second Division of the First Army Corps for a while drew their water supply. The location of Jay's Mill well, for instance, was such as to receive the drainage from typhoid fever infected camps near it, and it is not likely that this water escaped specific contamination. We are also inclined to attribute the greater prevalence of typhoid fever in the Third Army Corps to the fact that the sites covered by the regiments of this corps furnished many wet-weather springs, which in all probability were contaminated. That

the water was not infected at Jacksonville seems to be beyond question. This supply came from artesian wells more than 1,000 feet deep, and was distributed through the camps by means of pipes. In August and September of 1898 there were in round numbers at Jacksonville 30,000 civilians or inhabitants of the city and the same number of soldiers encamped near by. Both civilians and soldiers drank water from the same source. There were only a few sporadic cases of typhoid fever in the city at a time when each of the three division hospitals was receiving a score or more of patients with this disease each day. The same condition existed at Knoxville. Here the soldiers obtained their water supply from the pipes that furnished West Knoxville. We satisfied ourselves from an inspection of the health officer's books that there were no cases of typhoid fever among the citizens at that time, and still there were hundreds of cases among the soldiers.

At Camp Alger certain local water supplies probably became contaminated, but there is no evidence that this was generally true. Each regiment obtained its supply from a bored well, and while there was some question about the wisdom of the location of a few of these, the majority were so situated and so constructed that infection seemed well-nigh impossible. The same is true of the water supply at Camp Meade.

(*27*) *To guard against the contamination of the water supply, troops in the field should be provided with means for the sterilization of water.*

Our investigations of the methods of sterilization and cooling water have been given elsewhere. (See Report of the Surgeon-General of the Army, 1899, pp. 215–225.)

(*28*) *Flies undoubtedly served as carriers of the infection.*

Flies swarmed over infected fecal matter in the pits and then visited and fed upon the food prepared for the soldiers at the mess tents. In some instances where lime had recently been sprinkled over the contents of the pits, flies with their feet whitened with lime were seen walking over the food.

It is possible for the fly to carry the typhoid bacillus in two ways. In the first place, fecal matter containing the typhoid germ may adhere to the fly and be mechanically transported. In the second place, it is possible that the typhoid bacillus may be carried in the digestive organs of the fly and be deposited with its excrement.

(*29*) *It is more than likely that men transported infected material on their persons or in their clothing and thus disseminated the disease.*

We have condemned the method which was followed in many of the camps of detailing men from the ranks to act as orderlies at the hospitals. In some of the commands it was customary to detail 100 or more men from the line every morning. These men went to the hospitals, handled bed pans used by persons sick with typhoid fever, and at night returned to their comrades. The most of these men were

wholly ignorant of the nature of infection and the methods of disinfection. In fact, at one of the division hospitals we saw orderlies of this kind go from the hospital and partake of their midday meal without even washing their hands. These men handled not only the food which they ate, but passed articles to their neighbors. It seems to us that a more certain method for the dissemination of an infectious disease could hardly have been invented.

We have stated that in some of the camps the surface, especially where there were strips of wood, was frequently dotted with fecal deposits. At the time of our inspection of the Third U. S. Volunteer Cavalry at Chickamauga it was quite impossible to walk through the woods near the camp without soiling one's feet with fecal matter. Much of this was probably specifically infected, and it is by no means improbable that the infection was carried by the men into their tents, where blankets and tentage became infected.

(*30*) *Typhoid fever, as it developed in the regimental organizations, was characterized by a series of company epidemics, each one having more or less perfectly its own individual characteristics.*

The truth of this statement will be evident after the inspection of the charts showing the distribution of typhoid fever among the companies of the different regiments. On making such an inspection, one must be impressed with the fact so plainly evident there that men who are closely associated develop typhoid fever simultaneously. Men in the same company came down with the disease on the same day. This is still more marked when we study the cases with reference to the tents occupied by the men. Of 1,608 cases of typhoid fever which we have been able to accurately locate in the particular tents in which they occurred, together with the date of commencement of the attack, the results may be summarized as follows:

Directly connectable attacks, 563, or 35.01 per cent.

Indirectly connectable attacks, 447, or 27.79 per cent.

Total connectable attacks, 1,010, or 62.80 per cent.

Certain tents were badly infected and the majority of all their inmates developed the disease, while other tents wholly escaped. Blankets and tentage became soiled with typhoid discharges and in this way the disease was propagated and carried by the company wherever it went. We believe, therefore, that personal contact was a very important factor in the spread of the disease.

(*31*) *It is probable that the infection was disseminated to some extent through the air in the form of dust.*

The shell roads through the encampment at Jacksonville were ground into the finest dust by the heavy army wagons. The scavenger carts carrying the tubs filled with fecal matter passed along these roads and their course could often be traced by bits of feces falling from the tubs. Other vehicles ground up the fecal matter and dust together and the winds disseminated these particles here and there.

Men inhaled this dust. It was deposited on food in the mess tents by the roadside, and men ate the dust. Pollution of the soil with the urine of those suffering with typhoid fever was of frequent occurrence. Cases of this disease under the diagnosis of malarial fever were repeatedly treated by the regimental surgeon throughout the entire sickness. Patients still convalescing were also returned to their respective companies. Under these conditions there must have been abundant opportunity for contamination of the camp site with the specific germ. We are therefore inclined to the opinion that infected dust was one of the factors in the dissemination of typhoid fever.

(*32*) *A command badly infected with typhoid fever does not lose the infection by simply changing location.*

We do not mean to say that it is not advantageous for a regiment badly infected with typhoid fever to change its location. On the other hand, in our history of the Second Division of the First Army Corps we have shown that such change is of advantage and may be followed by a reduction in the number of cases; but mere change in location is not sufficient to stamp out the disease in a command after it has become widely disseminated. The histories of many regiments show this to be true. The Second Division of the First Army Corps became badly infected with typhoid fever at Chickamauga; later it moved to Knoxville, Tenn. At the latter place the location was an ideal one. The water supply was above suspicion; the surface gently rolling and the natural drainage good. The soil was deep, and pits of proper depths were easily constructed. Soil thrown out in digging the pits dried in the sun and became highly absorptive, so that when thrown back upon the fecal matter it took up the moisture readily. Notwithstanding all these favorable conditions typhoid fever continued, and instead of showing the slightest abatement increased in prevalence. The regiments that went from Chickamauga to Lexington, Ky., had a similar experience, although it is not so marked in these, because they had been more severely affected at Chickamauga, and a larger proportion of the susceptible material had been used up. The regiments of the First Division of the First Army Corps that went to Porto Rico carried the infection along with them but with little if any abatement. Numerous other illustrations equally striking might be given.

(*33*) *When a command badly infected with typhoid fever changes its location it carries the specific agents of the disease in the bodies of the men, in their clothing, bedding, and tentage.*

This is shown by the fact that when commands changed location, leaving behind them all their sick, and when they went to places free from the infection the disease continued with them.

(*34*) *Even an ocean voyage does not relieve an infected command of its infection.*

This is shown to be the case in the study of the various commands that went to Cuba and Porto Rico. The regiments constituting the Fifth Army Corps, that went from Tampa to Santiago in June, were not widely infected before embarkation, and some of them were on board ship for sixteen days and yet all developed one or more cases either on the way or soon after reaching Cuba. The regiments that went from Chickamauga were widely infected before leaving this country, and the disease continued after their landing with but little if any abatement.

(*35*) *After a command becomes badly infected with typhoid fever changes of location, together with thorough disinfection of all clothing, bedding, and tentage is necessary.*

Even when disinfection is carried out, as here suggested, the command will not altogether lose its typhoid infection, because some of the men will carry the germs of the disease in their bodies. Change of location removes the command from the infected locality; disinfection of clothing, bedding, and tentage destroys the infected material deposited upon these articles, but the germs that have already been introduced into the bodies of men are not so easily reached. The utility of disinfection of clothing, bedding, and tentage was demonstrated by Colonel Girard, who carried out this procedure in some of the most seriously infected regiments at Camp Meade with very gratifying results.

(*36*) *Except in case of the most urgent military necessity one command should not be located upon the site recently vacated by another.*

This principle holds good even when the vacating regiment is not known to have suffered from any infectious disease. This axiom in military hygiene was frequently violated during the summer of 1898. In many of the State encampments the regiments that responded to the second call were located on sites recently vacated by commands that had proceeded to the national encampments. This was true of the Fifteenth Minnesota, the Thirty-fifth Michigan, and the Two hundred and third New York, each of which had as many cases of typhoid fever as any one of the regiments in the great national encampments. The Third Illinois at Chickamauga was located upon ground which had recently been vacated by the Sixteenth U. S. Infantry. The regular regiment had occupied this site only eight days, and during this time had reported no sickness, but soon after it reached Tampa it developed 13 cases of acute intestinal catarrh, 3 cases of diarrhea, and 3 cases of typhoid fever. When the Second Brigade of the First Division of the First Army Corps reached Chickamauga Park, the site selected for the regimental camp of the Third Illinois occupied a part of that recently vacated by the Sixteenth U. S. Infantry, while the other regiments of this brigade were placed some distance away. This brigade remained at Chickamauga until July 22, during which time

the Third Illinois developed 60 cases of typhoid, the Fourth Pennsylvania 26 cases, and the Fourth Ohio 19 cases. Additional instances of this kind have been given in the body of our report.

(*37*) *The fact that a command expects to change its location does not justify neglect of proper policing of the ground occupied.*

The filthy condition of many of the regimental camps at Chickamauga was explained on the ground that each regiment expected to be called to the front in a few days and therefore neglected camp sanitation. It is needless for us to say that the explanation does not justify the neglect. A camp site should be thoroughly policed up to the moment of vacating it. This should be insisted upon as a matter of military discipline, and camp commanders should regard proper attention to the sanitation of the site occupied by their troops as one of their highest duties and the neglect as a crime.

(*38*) *It is desirable that the soldier's bed should be raised from the ground.*

In some of the regiments at Camp Alger the tents were never floored. On inspecting these commands in August we found dust several inches deep in the tents. During the daytime, in fair weather, the blankets were taken out, and men, possibly with their feet soiled with infected material, walked around in the dust and at night threw the blankets down on it and there slept. At other encampments flooring was purchased with regimental funds. We admired the enterprise of the men in some regiments who built in their tents a scaffold of poles, covered this with straw, and made their beds on this. We can not but think that sleeping in a dust pile, which was possibly infected with typhoid stools, was not wise.

(*39*) *In some of the encampments the tents were too much crowded.*

This was true both of the space allowed for the tents and of the number of men occupying each tent. In some instances the tents of the same company were so close together as to leave no space between them, and those of two adjacent companies were crowded together back to back. Inasmuch as none of these commands were in the vicinity of any hostile camp, this overcrowding seems to have been wholly unnecessary. Medical officers should vigorously remonstrate against arrangements of this kind. In some of the commands at Chickamauga the tents were not shifted, but stood continuously on the one spot where they were pitched in May until the command left late in August.

(*40*) *Medical officers should insist that soldiers remove their outer clothing at night when the exigencies of the situation permit.*

With from 12 to 16 men in a tent, all sleeping in their clothes worn during the day, and possibly with some of them soiled with infected fecal material, the effect upon the general health certainly could not be beneficial, and the possibility of the dissemination of infection

must be admitted. If privates in the ranks would give more attention to personal cleanliness, and if they were furnished with quarters in which they could keep themselves clean, typhoid fever and other infectious diseases among troops in the field would be greatly decreased. Our investigations show that tent infection must have been an important factor in the distribution of typhoid fever.

(*41*) *Malaria was not a prevalent disease among the troops that remained in the United States.*

We have shown in the body of this report that blood examinations for the plasmodium of malaria made by competent men at Camp Alger, Chickamauga, Knoxville, Camp Meade, and Jacksonville show that malaria was a very rare disease among the troops that remained in the United States. This disease was undoubtedly more common in some of the camps than the blood examinations would indicate, because these were made for the most part on hospital patients and not upon those who merely reported to the regimental surgeon, were given quinine, and returned to duty in a day or two. The malaria that did exist in the national encampments in this country yielded readily to quinine, and the cases that did not yield to this treatment were not malarial. It is unfortunate for scientific medicine that a competent man, properly equipped for making blood examinations, was not stationed at each division hospital at the time of its organization. Certainly we have a right to expect that the Government will use the best and the most scientific methods in its Army medical service. Had this been done scientific medicine would have been enriched by contributions of the greatest value. Is it too much to ask that a division hospital be furnished with facilities for scientific diagnosis equivalent to those possessed by all first-class hospitals?

(*42*) *The continued fever that prevailed among the soldiers in this country in 1898 was typhoid fever.*

There is no evidence that any other continued fever was found among the troops that remained in the United States. We have mentioned the claim of one surgeon that dengue prevailed in his regiment at Chickamauga. We think it quite impossible for dengue to have prevailed in one regiment while all other troops of two army corps encamped at the same place escaped this disease. It was claimed by some that the continued fever prevalent at Chickamauga differed from typhoid fever, and that it was a disease peculiar to the place, and it was designated as "Chickamauga fever." That the continued fever prevalent in our camps in 1898 was typhoid fever is demonstrated by the following facts:

(*a*) When the temperature curve was not vitiated by the use of antipyretics it was that of typical typhoid fever.

(*b*) The fever was not broken or arrested by the administration of quinine.

(*c*) The death rate was that of typhoid fever.

(*d*) Whenever a post-mortem examination was made, and the total of these examinations was considerable, the characteristic lesions of typhoid fever were found.

(*43*) *In addition to the recognized cases of typhoid fever, there were many short or abortive attacks of this disease which were generally diagnosed as some form of malarial fever.*

While entertaining the opinion that many of the short febrile attacks were due to errors in diet, as our own investigations proceeded we strongly inclined to the belief that a considerable proportion of these fevers of short duration were due to infection with the typhoid bacillus, and hence were to be considered as cases of mild or abortive typhoid fever. In other parts of this report we have called attention to the coincident rise and fall of these supposed malarial fevers with the occurrence of recognized typhoid fever in certain companies and regiments. Our studies have shown that those soldiers who had recovered from these supposed malarial fevers of short duration afterwards possessed a relatively marked immunity against typhoid fever, as compared with those who had not suffered with these milder fevers. The following table will give the result of our investigation bearing on this point in forty-eight regiments of the Second and Seventh Army Corps.

Table showing, for forty-eight regiments of the Second and Seventh Army Corps, the cases of typhoid fever among men with or without preceding malarial diseases.

Camp.	Number of regiments.	Mean strength.	Cases of malaria.	Typhoid fever with preceding malaria.		Men in regiments not having had malaria.	Typhoid fever without preceding malaria.		Total cases of typhoid fever.
				Number of cases.	In 100 malarial cases.		Number of cases.	In 100 individuals who had no malaria.	
					Per ct.			*Per cent.*	
Alger	19	21,988	4,083	63	1.5	17,905	1,888	10.5	1,951
Jacksonville	7	7,990	2,366	46	1.9	5,624	1,246	22.1	1,292
Meade	13	15,092	1,430	72	5.0	13,662	2,305	16.9	2,377
Jacksonville	9	10,759	1,676	81	4.8	9,083	2,044	22.5	2,125
Total	48	55,829	9,555	262	2.7	46,274	7,483	16.1	7,745

Thus, in a mean strength of 55,829 men, there were 9,555 who had experienced attacks of fever, which was generally designated as some form of malarial disease, most frequently as malarial remittent fever Of this number only 262, or 2.7 per cent, suffered from subsequent attacks of typhoid fever. On the other hand, of 46,274 men who did not experience any attack of supposed malarial fever, 7,483, or 16.1 per cent, contracted typhoid fever.

(*44*) *While our examinations show that coincident infection with malaria and typhoid fever may occur, the resulting complex of symp-*

toms are not sufficiently well defined and uniform to be recognized as a separate disease.

We have in the body of this report devoted a special chapter to this subject, to which those desiring detailed information are referred.

(*45*) *About one-fifth of the soldiers in the national encampments in the United States in 1898 developed typhoid fever.*

Among 107,973 officers and men in 92 regiments, the records of which we have carefully studied, the number of cases of typhoid fever, according to our estimate, was 20,738. This is equivalent to 19.26 per cent.

(*46*) *Army surgeons correctly diagnosed about half the cases of typhoid fever.*

The total number of probable cases of typhoid fever among the 92 regiments studied was 20,738. Of these 10,428, or 50.27 per cent, were diagnosed as typhoid fever either by regimental or hospital surgeons. Most of the cases improperly diagnosed were sent to general military hospitals or to civil hospitals with the diagnosis of malaria. In 80 out of 85 cases sent from the Fifth Maryland to civil hospitals in Baltimore, the diagnosis was changed from malaria to typhoid fever. Out of 98 cases sent from the Eighth New York to hospitals in New York City on September 9, all were recognized as typhoid fever by the physicians in charge of the hospital, while the majority of these cases had been entered on the sick reports under other diagnoses. Of 101 cases of fever transferred to the hospitals at Hartford and New Britain, Conn., by the First Connecticut Infantry, on its departure from Camp Alger, Va., September 7, 1898, 98 received the diagnosis of typhoid fever, and only 3 the diagnosis of malaria. The failure of the regimental surgeon to properly diagnose many cases of typhoid fever is easily explained. Orders required, very properly, that every man sick for forty-eight hours should be sent to the division hospital. It will be seen from this that the cases were not under the observation of the regimental surgeon for a sufficient time for him to make a diagnosis. There is also some excuse for the failure of the surgeons at the division hospitals to recognize all cases of typhoid fever. Many of the less severe of these cases remained in hospital for a short time and were furloughed home or forwarded to some general hospital. Moreover, we have shown in the body of our report that in recognizing nearly half the cases of typhoid fever the army surgeon probably did better than the average physician throughout the country does in his private practice.

(*47*) *The percentage of death among cases of typhoid fever was 7.61.*

Of the 20,738 cases already mentioned as occurring in 92 regiments, 1,580 died. This gives a death rate of 7.61 per cent. This corresponds closely with the death rate for typhoid fever in those places in which most accurate records have been kept. In the city of Hamburg

during the years 1886 and 1887 there were 10,823 cases, with a death rate of 8.5 per cent. In 1897 there were 1,885 cases at Maidstone, England, with a death rate of 7.5. Brandt has collected 19,017 cases treated by cold baths, with a mortality of 7.6 per cent. Of 2,293 cases treated in some of the larger hospitals in this country in 1897, 9.24 per cent died.

(*48*) *When a command is thoroughly saturated with typhoid fever it is probable that one-fourth to one-third of the men will be found susceptible to this disease.*

We are inclined to the opinion, but desire to state it only as an opinion, that typhoid fever disappeared in some of the regiments only after all the susceptible material had been exhausted. This was probably true in all regiments which had 400 or more cases.

(*49*) *In military practice typhoid fever is often apparently an intermittent disease.*

We have stated that typhoid fever is often apparently an intermittent disease. We do not mean that the apparent intermissions are afebrile; we only mean that the men sick with this disease had periods of improvement, and these were so marked that regimental surgeons sometimes returned to duty, probably at the request of the men, those who were sick with typhoid fever.

(*50*) *The belief that errors in diet with consequent gastric and intestinal catarrh induce typhoid fever is not supported by our investigations.*

This belief, which was formerly held by many, is founded upon false conclusions arising from erroneous conceptions of the etiology of the disease. Moreover, the early symptoms of typhoid fever are often confounded with those of simple gastro-intestinal catarrh.

(*51*) *The belief that simple gastro-intestinal disturbances predispose to typhoid fever is not supported by our investigations.*

As has been elsewhere stated, the members of this board began their investigations with the belief, which seems to be quite generally held, that acute diseases of the gastro-intestinal tract render the individual more susceptible to subsequent infection with typhoid fever. However; our studies have forced us to come to the following conclusions concerning the relations between typhoid fever and preceding temporary disorders, including those diagnosed as diarrhea, enteritis, gastro-enteritis, gastro-duodenitis, intestinal catarrh, gastro-intestinal catarrh, gastric fever, and simple indigestion:

(*a*) The temporary gastro-intestinal disturbances of May and June had little if any effect upon subsequent infection with typhoid fever.

(*b*) The temporary gastro-intestinal disturbances of July and August, instead of predisposing to typhoid fever, gave a certain degree of

immunity against subsequent infection with this disease. Our investigations may be summarized as follows:

Table showing for forty-eight regiments of the Second and Seventh Corps cases of typhoid fever among men with or without preceding diarrheal diseases.

Camp.	Number of regiments.	Mean strength.	Diarrheal diseases.		Cases of diarrheal diseases followed by typhoid fever.		Number of men who had no preceding diarrhea.	Typhoid fever without preceding diarrheal diseases.		Total cases of typhoid fever.
			Number of cases.	Number of individuals.	Number of cases.	In 100 men with preceding diarrhea.		Number of cases.	In 100 individuals who had no diarrhea.	
Alger	19	21,988	5,354	3,894	174	4.4	18,094	1,777	9.8	1,951
Jacksonville	7	7,990	2,370	1,877	131	6.9	6,113	1,161	18.9	1,292
Meade	13	15,092	2,048	1,857	179	9.1	13,235	2,198	16.6	2,377
Jacksonville	9	10,759	2,056	1,853	164	8.8	8,906	1,961	22.2	2,125
Total	48	55,829	11,828	9,481	648	6.8	46,348	7,097	15.3	7,745

It will be seen that of 9,481 men who had previous diarrheal attacks, 648, or 6.8 per cent, contracted typhoid fever; whereas of 46,348 soldiers who had no preceding diarrhea, 7,097, or 15.3 per cent, developed typhoid fever.

(*52*) *In a considerable per cent (a little more than one-third) of the cases of typhoid fever which are recorded as having been preceded by some intestinal disturbance, the preceding illness was so closely followed by typhoid fever that we must regard the former as having occurred within the period of incubation of the latter.*

For particulars on this point see the chapter on etiology.

(*53*) *More than 90 per cent of the men who developed typhoid fever had no preceding intestinal disorder.*

In 7,745 cases in which this point was especially investigated 7,097 (91.63 per cent) were not preceded by any intestinal disorder.

(*54*) *The deaths from typhoid fever were 86.24 per cent of the total deaths.*

(*55*) *The morbidity from typhoid fever per 1,000 of mean strength was a little less than one-fifth (192.65).*

The highest morbidity was in the case of the Forty-ninth Iowa Infantry, and the lowest in the Second Pennsylvania Infantry, a regiment which never reached a national encampment.

(*56*) *The mortality from typhoid fever per 1,000 of mean strength was 14.63.*

The following table contains data illustrating these points:

Command, etc.	Number of regiments.	Mean strength.	Cases of typhoid fever.		Deaths from typhoid fever.	Deaths from all diseases.
			Certain.	Certain and probable.		
First Army Corps (Chickamauga)	22	27,380	2,912	5,921	344	397
Third Army Corps (Chickamauga)	17	20,568	1,741	4,418	417	469
Fourth Army Corps (Chickamauga)	7	7,507	440	1,498	99	112
Second Army Corps (Alger)	18	19,807	1,807	2,226	212	259
Second Army Corps (Meade)	12	13,962	1,799	2,690	150	168
Seventh Army Corps, Second Division (Jacksonville)	9	10,759	1,729	2,693	248	281
Total	85	99,983	10,428	19,446	1,460	1,686
Seventh Army Corps, Third Division	7	7,990	.....	1,292	120	146
Grand total	92	107,973	.....	20,738	1,580	1,832

Command, etc.	Number of regiments.	Deaths from typhoid fever in 100 cases.		Percentage of deaths from typhoid to deaths from all diseases.	Morbidity of typhoid fever in 1,000 mean strength.		Deaths from typhoid in 1,000 of mean strength.
		Certain typhoid.	Certain and probable type.		For certain cases of typhoid.	For certain and probable cases of typhoid.	
First Army Corps (Chickamauga)	22	11.46	5.64	84.13	106.35	216.25	12.19
Third Army Corps (Chickamauga)	17	23.95	9.43	88.91	84.64	214.79	20.27
Fourth Army Corps (Chickamauga)	7	22.50	6.60	88.39	58.61	199.54	13.17
Second Army Corps (Alger)	18	11.73	9.52	81.87	91.23	112.38	10.70
Second Army Corps (Meade)	12	8.33	5.57	89.28	128.84	192.67	10.74
Seventh Army Corps, Second Division (Jacksonville)	9	14.34	9.20	88.25	160.70	250.30	23.05
Total	85	14.00	7.50	86.59	104.29	194.49	14.60
Seventh Army Corps, Third Division	7	.....	9.28	82.19	.....	161.70	15.01
Grand total	92	.....	7.60	86.24	.....	192.65	14.63

(57) *The average period of incubation in typhoid fever is probably about ten and a half days.*

Our data are not sufficient to enable us to make any positive deduction on this point, but from a careful study of 780 cases of typhoid fever in which the period of incubation was based upon the average interval between connectable typhoid attacks in tents or between diarrheal and typhoidal attacks in the same individual this was found to be 10.4 days. The shortest period of incubation would appear to be slightly less than 8 days.

CHAPTER XV.

THE ETIOLOGY OF TYPHOID FEVER.

THE BACILLUS.

Typhoid fever is caused by a specific micro-organism, generally known, from its discoverer, as the Eberth bacillus. This bacterium finds its way with food and drink through the mouth and stomach into the small intestines, where it develops, produces specific lesions, and elaborates chemical poisons which induce the characteristic symptoms of the disease. In addition to its location in the walls of the intestines, this germ is usually found after death from this disease in the mesenteric glands and in the spleen. If proper bacteriological examination be made directly after death, the bacillus is usually found in pure culture in these organs. For this reason the spleen is generally selected for bacteriological study and for the preparation of cultures after death from typhoid fever. However, it seems to be possible for this bacillus to reach any part of the body and to find lodgment in various tissues, having been found in the lungs, liver, kidneys, bones, muscles, and brain. Its lodgment in diverse parts of the body and its long-continued existence in these localities are accountable for many of the varied sequelæ to typhoid fever.

Typhoid fever may run its course and terminate fatally without causing the intestinal ulceration, generally regarded as the specific lesion of this disease. More than 20 cases of death from this disease in which post-mortem examination has failed to show intestinal ulceration have already been recorded, and it is probable that this number will be increased by future observations. It must be evident from the existence of these cases that the bacillus may penetrate the intestinal wall without leaving a marked lesion and that the elaboration of its chemical poisons is not confined to the intestinal tract. It remains for future investigations to determine whether, ordinarily, in this disease the intestinal lesion precedes or follows the infection of the spleen and mesenteric glands. The existence of typhoid fever without intestinal ulceration emphasizes the desirability of a classification of diseases based upon etiology rather than upon pathology.

The evidence that the Eberth bacillus is the cause of typhoid fever consists of the following demonstrated facts:

(1) This bacterium is found in the spleen of every person dying of typhoid fever when a proper bacteriological examination of this organ is made.

(2) This bacillus elaborates poisonous substances in artificial culture media.

(3) The blood serum of individuals sick with typhoid fever has a specific agglutinative action on this bacterium.

The fact that none of the lower animals, so far as we know, ever develop typhoid fever, or are susceptible to this disease, as it mani-

fests itself in man, makes it impossible to obtain the experimentally conclusive evidence of the causal relationship of this germ to this disease that has been obtained in the study of the micro-organisms of certain other affections, such as anthrax, tetanus, tuberculosis, glanders, diphtheria, and some other maladies. All the animals ordinarily submitted to experimentation of this kind have been inoculated with this bacillus by diverse methods, but the results obtained have been inconstant in appearance and varied in character. Upon many animals the Eberth bacillus is without effect. In some the blood has a markedly destructive action upon this germ. In others, intoxication, which may result in death if the quantity employed be sufficient, but without the characteristics of true infection, follows. Very rarely the effect more nearly resembles an infection; but in none of the lower animals has there been induced by inoculation with this bacillus up to the present time a disease identical, either clinically or pathologically, with typhoid fever, as observed in man. It is true that in some of the lower animals after death resulting from intravenous inoculation with the Eberth bacillus, there may be found swelling, and, in isolated places, sloughing of the follicles of the small and large intestines, marked enlargement of the spleen, cloudy swelling of the kidneys, necrosis in the liver, and infiltration of the mesenteric glands. While these lesions resemble those of typhoid fever, they are by no means identical with those found in man after death from this disease, nor can it be said that the lesions just mentioned as occasionally observed in the lower animals are characteristic of the action of this germ, since other micro-organisms induce similar changes when introduced into these animals. Some observers have emphasized the fact that there is a tendency on the part of this bacillus to accumulate in the spleen of animals inoculated intravenously or intraperitoneally, and have seen in this phenomenon an evidence of the causal relationship of the Eberth bacillus to typhoid fever; but it is likewise a fact that a similar tendency to collect in the spleen is observable in inoculation experiments with many other bacilli.

Notwithstanding the great amount of experimental evidence collected concerning the effects of this germ upon the lower animals, we are still in doubt as to the extent to which it multiplies in the body after inoculation. However, we can state that in most of the lower animals the Eberth bacillus does not multiply after its introduction by inoculation, or does so to a very limited extent and for a very short time. It has been quite universally observed in experiments upon different species that if the animal does not succumb within two or three days at most, its recovery from the effects of the inoculation is certain. This indicates, as has been stated above, that death in the lower animals following inoculations with the Eberth bacillus is due to the chemical poisons contained in the culture, and can not be con-

sidered as the result of a true infection. It should be understood that these statements are founded upon experiments made up to the present time, and that they are not intended as prophecies. We know that the Eberth bacillus varies quite widely in virulence, and that its action can be greatly intensified by repeated passages through the bodies of the lower animals, and it may be found in the future that its infective power can under certain conditions be increased to such an extent that it may affect the lower animals similarly to man. Moreover, it must be recognized that experimental inoculation practiced on the lower animals is by no means identical with infection, as it ordinarily occurs in man. Animal experimentation has been of the greatest service in the study of the etiology of this and other diseases, but that the conditions attending these experiments are not identical with those accompanying natural infection is evident to all. Experiments upon the lower animals with the Eberth bacillus have been made with pure cultures, a condition which never prevails in the intestines of the man who develops typhoid fever. The man who drinks water infected with typhoid bacilli takes into his alimentary canal at the same time other micro-organisms. Moreover, the newly introduced bacilli find in the intestines more or less abundant growths of other micro-organisms which vary within certain limits from time to time. In view of the few facts that we know concerning the influence of one bacterium upon the virulence of another, we are hardly justified in assuming that a pure culture of the Eberth bacillus will induce, either in man or in the lower animals, the same effects as those that follow infection in the presence of other micro-organisms.

Notwithstanding the fact that we have been unable to induce typhoid fever in the lower animals by inoculation with the Eberth bacillus, we have still good reasons for adhering to the opinion that this micro-organism is the specific cause of this disease. Numerous competent observers have made frequent bacteriological examinations of the spleens of those dead from typhoid fever, and in all cases the Eberth bacillus has been detected, generally in pure culture in this organ. It is true that this bacillus does not always show exactly the same tinctorial and cultural characteristics, and that it is modified to some extent by the soil upon which it grows and the conditions under which it develops.

Furthermore, it may be said that every one of the so-called crucial tests that have been proposed for its positive identification has been found to be fallible. Nevertheless, from a large number of comparative studies of the bacilli obtained from the spleen after death from typhoid fever, in epidemics widely separated geographically, we must conclude that the germ invariably found in this organ is one and the same, in spite of certain minor differences. While the constant appearance of this bacillus in the bodies of those dead from typhoid fever by no means proves the organism to be the cause of the disease,

it forms the first link in the chain of evidence necessary to the demonstration of this relationship. Certainly if the bacillus were not present in all cases it could not be the cause of the disease, and from what we know of other infectious maladies, the constant presence of this germ in typhoid fever is strong presumptive, but not conclusive, evidence that it is the cause of the disease.

The fact that the Eberth bacillus is toxicogenic is corroborative evidence of its causal relationship to typhoid fever. If the germ were not poisonous it could not cause the disease. Putting together the facts, (1) the germ is found in the body in all cases of typhoid fever, (2) it is not found in the body except in typhoid fever, (3) it produces poisons, the evidence that the Eberth bacillus is the cause of typhoid fever falls but little short of being conclusive. However, it must be admitted that there still remains some ground for argument. For instance, it might be said that the elaboration of chemical poisons by a given micro-organism in artificial culture media is no proof that the same substances are produced when the micro-organism multiplies in the human body. On this point, also, experimental evidence seems to be incapable of bringing us to an unquestionable conclusion. Granting that the Eberth bacillus forms the same poison or poisons in the animal body that it does in artificial culture media, it remains a difficult task to demonstrate that the products of its growth are the specific poisons of typhoid fever. In the first place, it can hardly be expected that the symptoms resulting from the relatively slow but long-continued elaboration of a poison within the body can be identical with those following the sudden introduction of a relatively large amount of the same poison into a healthy animal. In the second place, it is a well-known fact that many poisons vary quite markedly in their effects upon different species of animals. For these reasons it would not be a matter of surprise if we possessed beyond question the specific poison or poisons of typhoid fever to find that these would fail to induce in the lower animals a clinical picture of the symptoms of typhoid fever as it is seen in man. Therefore, it follows that, although neither the bacillus nor its chemical products produce in the lower animals the symptoms characteristic of typhoid fever in man, this micro-organism may still be the specific germ and its products the specific poisons of typhoid fever.

It may be of interest to make a brief statement concerning our present knowledge of the poisonous products of the Eberth bacillus. In 1885 Brieger obtained from pure cultures of this germ a poisonous base which induces in guinea pigs an increased flow of saliva, frequency of respiration, dilatation of the pupils, profuse diarrhea, muscular paralysis, and death within from twenty-four to forty-eight hours. Post-mortem examination of these animals shows the heart to be in systole, the lungs hyperæmic, and the intestines contracted and pale. This basic substance was at first believed to be the specific

poison of typhoid fever, and with this idea Brieger christened it typhotoxin; but more recent and more elaborate investigation has shown that the poisonous products of the Eberth bacillus are more complicated than is indicated by the discovery of this comparatively simple chemical substance. The existence of a poisonous proteid within the cells of this germ has been demonstrated by a number of independent investigators. A noteworthy fact in this connection is the discovery that by means of repeated relatively small injections of this proteid body animals can be rendered immune to virulent cultures of the bacillus. This indicates that the complex proteid contained within the cell of the germ constitutes the specific poison of the disease. The determination of the chemical constitution of this body awaits further research. It is within the range of possibility that the chemical poison to which the complex of symptoms characteristic of typhoid fever is due may result, in part, at least, from mixed cultures present in the intestines of the individual suffering from this disease. From typhoid stools there has been obtained a poisonous substance which, when injected hypodermically in dogs or administered by the mouth, causes an elevation of temperature accompanied by vomiting and purging. At present our knowledge concerning the chemistry of the etiology of typhoid fever is general and vague, and additional research is necessary before satisfactory statements concerning it can be made.

Additional evidence that the Eberth bacillus is the specific bacterium of typhoid fever is furnished by observing the effect of blood serum from an individual sick with this disease, or recently recovered from the same, upon the germ. A few years ago Pfeiffer discovered that the blood serum of an animal which had been rendered immune to a given germ manifests a specific and characteristic action upon this germ when both are introduced into the body of a healthy animal. The details of the experiments may be carried out as follows:

Render a guinea pig or other animal immune to the typhoid or other bacillus by repeated inoculations with small quantities of the bacillus. Take a fraction of a drop of the serum obtained from the blood of the animal thus rendered immune to the given germ, add a loop of the culture of this germ to the serum, and inject the mixture into the abdominal cavity of a healthy guinea pig. After a short time open the abdominal cavity of this animal and make a microscopical study of the organism which has been introduced as above described. Instead of opening the abdominal cavity some of the peritoneal exudate may be removed from time to time by means of a sterilized capillary pipette. It will be found that the bacterial cells are undergoing a characteristic degeneration. Almost immediately after the injection of the germ and serum the former becomes nonmotile and later is converted into a granular body, which apparently dissolves in the surrounding fluid. This phenomenon, which is generally designated as Pfeiffer's reaction, is believed to be in the high-

est degree specific. Blood serum from an animal rendered immune to the cholera vibrio will have the above-described effect upon the cholera bacillus and upon no other micro-organism. Likewise, the blood serum of an animal immune to typhoid fever is necessary in order to induce these changes in the Eberth bacillus. It is generally believed by bacteriologists that this reaction is so certainly specific that it can be relied upon in distinguishing one germ from another after all attempts to do so by other means have failed.

Later, Gruber and Durham discovered that a specific action of the blood serum of an animal suffering from a given infectious disease or recently recovering from the same upon the germ of this disease may be observed outside the body. If a few drops of blood serum from an animal which has been rendered immune to a given germ be mixed with a loop of a growing culture of this organism and the mixture be examined under a microscope, it will soon be seen that the bacterial cells are quite markedly affected by the fluid in which they find themselves. The bacilli lose motility and collect in clumps or agglutinate. The very dilute blood serum from an immune animal manifests this specific action upon the germ against which the immunity has been secured, but not upon any other micro-organism. It is true that the blood serum from healthy animals has more or less agglutinative action, but the phenomenon takes place in high dilutions of blood serum only when the latter has been obtained from an animal rendered immune to the specific germ under examination. Blood serum from an animal rendered immune to the cholera bacillus agglutinates this germ, but is without effect upon the typhoid bacillus; while, on the other hand, the blood serum from an animal rendered immune to the Eberth bacillus agglutinates this organism and is without effect upon the cholera vibrio or any other micro-organism. It will be seen from these statements that the phenomenon of agglutination is believed to be in the highest degree specific. Therefore, when Widal discovered that blood serum obtained from a man suffering with or recently recovered from typhoid fever has an agglutinative action upon the Eberth bacillus similar to that observed in the blood serum of animals rendered immune to this germ, the evidence of the causal relationship of this micro-organism to typhoid fever was greatly strengthened. As is well known, the Widal test has been extensively used in all parts of the civilized world as a means for the recognition of typhoid fever, and its value has been quite positively established. It should be stated in this connection that the agglutination reaction is, in man, at least, a phenomenon of infection rather than one of immunity.

With the above-mentioned evidences before us, it must be admitted that there is but little room left to doubt that the Eberth bacillus is the specific micro-organism of typhoid fever. However, it must not be inferred that the bacteriology of typhoid fever needs no further

investigation. There are many problems yet to be solved. We will refer to only a few of these at this time. The distinction between the typhoid bacillus and the colon bacterium is not well defined. It is easy enough to distinguish between a typical colon bacillus and a typical typhoid bacillus. The former coagulates milk, ferments glucose or lactose, and produces indol by its growth in ordinary nutrient media. The typical typhoid bacillus does none of the above-mentioned things, but there are germs which ferment glucose and lactose more or less energetically, but do not coagulate milk or produce indol. There are others which show traces of indol in their culture growths, but do not coagulate milk or ferment glucose. In other words, there are micro-organisms which at present we can not place in either the colon or the typhoid group, and the relation of these to typhoid fever has not as yet been determined. We are in the habit of designating these bacteria as typhoid-like bacilli. They have been found in water supposed to be the cause of epidemics of typhoid fever. In a few instances they have been obtained from the blood during life and the spleen after death in cases which clinically could not be distinguished from typhoid fever. Some of them agglutinate more or less markedly in blood serum obtained from individuals suffering from typhoid fever. Many additional observations must be made before we can determine with certainty the proper classification of these organisms. In this connection we may state that in our investigation of typhoid fever in the national encampments of 1898 we found no reason for supposing that the colon bacillus is ever transformed into the typhoid bacillus. This subject will receive additional attention later.

The natural distribution of the typhoid bacillus is another subject needing careful investigation. Apparently trustworthy bacteriologists have reported the finding of this micro-organism in the most unexpected places. It has been detected in the soil of localities far removed from the habitations of man and has been isolated from drinking water supposed to be free from contamination. Furthermore, its presence has been reported in the stools of healthy persons as well as in those suffering from dysentery and simple diarrhea. It must remain for future studies to decide upon the reliability of these reported findings and to attach to them their proper significance should they be found to be true.

THE ELIMINATION OF THE BACILLUS FROM THE BODY.

It is important in a study of the etiology of typhoid fever to ascertain by what avenues the specific micro-organism leaves the body of the infected individual. The exhaled air from the lungs of the typhoid-fever subject is germ free, as it probably is in all infectious diseases. There is therefore no possibility of this disease being spread by means of the air exhaled from the lungs. This statement

is true only when the exhaled air is free from sputum. In the pneumonias that complicate typhoid fever the Eberth bacillus is found in the diseased lungs and may be eliminated in the matter coughed up and disseminated through the air in the fine spray that accompanies severe fits of coughing. However, the spread of typhoid fever in this manner must be regarded as a bare possibility.

There is no positive evidence that the perspiration from one sick with typhoid fever contains the specific bacillus of this disease. It is true that this bacterium may be found on the surface of individuals sick with this disease, but in such cases the germ owes its presence in this locality to contamination of the skin with the stools or with the urine. It is possible that under exceptional circumstances this bacillus may find its way to the surface from the blood, as it occurs in the eruptive spots of typhoid fever.

The urine of one sick with typhoid fever may or may not contain the Eberth bacillus. Several observers have found the living virulent bacterium in the urine, especially when this secretion contains albumin. In some of these cases it is more than probable that the germ has found lodgment in the kidney and has produced more or less extensive structural changes in that organ. However, the bacillus may be abundant in the urine when this secretion contains no albumin and when there is no other evidence of structural disease of the kidney. Persons recovering from typhoid fever may continue for weeks to eliminate in the urine millions of the Eberth bacillus. It sometimes happens that a cystitis occurs as a sequel to typhoid fever. In at least some of these cases the inflammation of the bladder is due to infection with the typhoid bacillus, and this germ in a virulent form may after a long time remain in the bladder and render the urine a possible source of the spread of typhoid fever. Houston [1] has reported a case of cystitis of three years' standing due to the infection of the bladder with the bacillus of Eberth. An interesting point in connection with the report of this case is that the patient never had typhoid fever, but had nursed cases of this disease. Further evidence will be needed before we can accept the possibility of an infection of this kind. However this may be, the occurrence of the specific microorganism in the urine in cases of typhoid fever is of sufficient frequency to demand that this secretion be disinfected in every case of this disease. Post-typhoidal abscesses may form in various parts of the body and may discharge the Eberth bacillus in virulent form for months and even years. It is unnecessary to add that infected material of this kind should be burned or otherwise disinfected. The necessity for this is evident whether the abscesses be due to the typhoid bacillus or to other bacteria.

The most important avenue for the elimination of the typhoid bacillus from the body is through the bowel. Long before the dis-

[1] Houston, British Medical Journal, 1899, vol. 1, p. 78.

covery of the specific micro-organism of this disease man had learned that the stools of typhoid patients contained the infective agent of the disease. It had been frequently observed that epidemics of typhoid fever resulted from the drinking of water contaminated with the stools of those suffering from this disease. The more intelligent members of the medical profession recommended thorough disinfection of the feces long before the bacillus had been discovered. The elimination of the typhoid bacillus in the stools probably begins soon after its introduction through the mouth. Indeed, it is quite certain that an individual may become the bearer and distributer of the infecting agent of typhoid fever without developing the disease himself. The specific bacterium finds its way into the small intestines, in the contents of which it multiplies rapidly, and this intestinal culture may be wholly discharged from the bowels without inducing any local lesions. Furthermore, as we have already seen, typical typhoid fever may develop and death result without intestinal ulceration.

We desire to emphasize the fact that the typhoid bacillus may grow in the intestines of an individual and pass from the same without causing typhoid fever. This is most likely to occur when many irritative saprophytic germs are taken into the alimentary canal along with a few typhoid bacilli. A few hours after infection with such a mixed culture the saprophytic germs may cause a profuse diarrhea, which sweeps from the intestines the typhoid bacilli. This is probably the true explanation of the unquestionable protective effect of diarrheas in certain epidemics of typhoid fever. We shall have occasion to refer to this later. Moreover, it is probable that a considerable proportion of adult individuals are to some extent, at least, immune to typhoid fever. The specific germ of this disease may be transported from one place to another in the intestines of an immune man, and when cast out in the stools may become a source of danger to others. It is probably in some such way as this that epidemics of typhoid fever sometimes appear to originate de novo.

The stools of individuals sick with typhoid fever constitute the most important source for the spread of this disease, and it may be stated in a general way that typhoid fever is due to the transference of some part of the feces of an infected individual to the alimentary canal of one susceptible to this infection. This transference in exceptional cases may be quite direct, as when a careless nurse soils her hands with the dejections from her typhoid-fever patient and eats her food without disinfecting her soiled fingers. Generally, however, the transference is more indirect and the germs in the infected stools may multiply through many generations and be transported by water or otherwise through considerable distances. Moreover, as has been indicated already, the bacilli may pass through an intermediate host, which may be man or one of the lower animals. An immune individual may visit a distant city, the water supply of which is infected

with the typhoid bacillus, and he may carry this infection to his village home, where it may be deposited in his normal stool, may find its way into the local water supply, and cause an epidemic of the disease.

Typhoid bacilli are most abundant in the stools of patients suffering from this disease when there is sloughing of the intestinal ulcerations. However, it should be borne in mind that typhoid stools are infectious often before the individual shows any evidence of the disease. In other words, the stool of a man in the incubation period of typhoid fever may be laden with the bacilli of this disease. In this way every latrine in an encampment may be infected with the specific micro-organism of typhoid fever before the disease has developed sufficiently in the individual to be recognized clinically. On the other hand, the stools may continue to be infectious long after convalescence has set in. So great is the danger of the spread of this disease from infected stools that in all cases where fecal matter can not be removed by water carriage, or otherwise, from immediate proximity with human habitation, all stools, those of both sick and well, should be thoroughly disinfected.

Notwithstanding the fact that the typhoid bacillus is abundant in the stools of individuals suffering from this disease, its isolation and identification in the feces is one of the most difficult tasks undertaken by the bacteriologist. This difficulty lies in the separation of the typhoid bacillus from other bacilli, which it resembles in some respects and which are present in the stools in much larger numbers. The colon bacillus, always present both in normal and typhoid stools, grows so abundantly and may resemble the typhoid bacillus so closely that the separation of the two is difficult and often impracticable. It is unfortunate that we have no reliable method of detecting the typhoid bacillus in mixed cultures of this germ and the bacterium coli. Such a method would supply us with a more ready and sure means for the early recognition of typhoid fever than we now possess, and it is to be hoped that future investigations will furnish a practical solution of this question. Many devices dependent upon supposed cultural peculiarities have been proposed and success has been promised many times, but up to the present no reliable, easily applicable method for the detection of the typhoid bacillus in stools has been discovered.

LONGEVITY OF THE TYPHOID BACILLUS.

It must be evident that in studying the problem of the spread of typhoid fever it is of the greatest importance that we should know how long the specific bacillus of this disease will continue to live and be possessed of its specific properties. It is equally evident that when seeking for an answer to this question we must know something of the conditions under which the life of the organism is to be perpet-

uated. We have already seen that in the human body the Eberth bacillus may continue to grow and reproduce its kind quite indefinitely. This is shown to be the case in instances of post-typhoidal cystitis and abscess. We would not have it understood that we suppose cases of typhoid fever to be frequently due to infection from these sources, and we have mentioned these facts simply for the purpose of showing how long an individual may retain the Eberth bacillus in some part of his body Certainly there is a possibility of infection spreading to others from the germ found in these post-typhoidal conditions, but such cases must be rare, except when the urine is infected. Probably the greatest source of danger in these conditions is to be found in the fact that the urine and the stools of individuals who have recovered from typhoid fever may continue to furnish the infective agent for a long time.

The living germ has been found in the bodies of men dead from typhoid fever after three months. However, the longevity of this bacillus in the dead body must be very variable and dependent upon a number of conditions which are not likely to be exactly the same in any two cases.

So far as the spread of typhoid fever is concerned, the longevity of its bacillus after it leaves the body of the infected man is of greater importance than its possible longevity in the body. When material containing this germ is spread out in a thin layer and exposed to the direct action of the sunlight, the bacilli are soon destroyed. A cloth moistened with a culture of the Eberth bacillus and exposed to the direct sunlight soon fails to yield a growth when a bit of it is placed in a suitable culture medium. However, we must not get too much comfort out of the fact that the typhoid bacillus is killed by an exposure of a few hours to the light of the sun. Practically typhoid stools are not spread out in thin layers or otherwise placed in a condition necessary for the light to have a markedly germicidal action. In the interior of a mass of fecal matter the germ may retain its vitality for a long time. It is true that the bacilli, when a small quantity of typhoid stool is smeared on a sheet, may be destroyed by a few hours' exposure to direct light, but the same material rolled in heavy blankets may retain its virulence for many weeks. Complete desiccation soon destroys the Eberth bacillus, but it may retain its vitality in relatively dry material for a long period. Bits of agar or gelatine cultures placed upon cloth, leather, wood, or metal retain the living bacillus for many months, and clothing and bedding soiled with typhoid stools may be the means of spreading this disease. The experiments of Uffelmann[1] show that the bacillus may retain its vitality in layers 4 mm. thick on wood for thirty-two days, on linen for sixty days, and on woolen cloth for eighty days.

The experiments that have been made in order to determine the

[1] Uffelmann, Centralblatt für Bakteriologie und Parasetenkunde, 1894.

longevity of this bacillus in the soil have yielded widely different results. This is explained by the fact that no two investigators have experimented under exactly the same conditions. When cultures of the Eberth bacillus are mixed with dust or pulverized earth of any kind and completely desiccated the germs speedily die, but when the desiccation is not complete the bacilli may retain their vitality for weeks and months. Because desiccation soon destroys the germ of typhoid fever, it has been inferred that this disease can not be spread by means of particles of dust carried through the air. We will return later to a discussion of this point, but it may be stated here that particles of dust carried through the air are by no means always completely desiccated. Currents of air may and do carry through great distances considerable particles of moist dust. Considerable interest is attached to the question of the vitality of this organism in the soil about sinks and privies containing typhoid stools. After the Franco-German war it was found that typhoid fever continued to prevail for some years in German garrisons in which German soldiers or French prisoners sick with typhoid fever had lived. One interesting case of this kind may be referred to. In this instance an epidemic of typhoid fever began among German soldiers located in a certain garrison on April 4, 1872. During the war these barracks had been occupied by French prisoners among whom typhoid fever had prevailed. Large sinks had been filled with the undisinfected stools of the prisoners, and when full these pits, which were located just outside the barracks, were covered in with thin layers of earth. The water of a well near by had probably become infected from these sinks and caused the epidemic in the garrison in 1872. These old sinks were cleaned out and the well closed. Four days later the last case of typhoid fever occurred in this garrison.

Recently interesting experiments have been made in England for the purpose of determining the longevity of the typhoid bacillus in soil. Martin took specimens of dirt from various sources. Some of these samples were obtained from localities where it was known that the soil was largely contaminated with organic matter and where typhoid fever had been endemic; others were obtained from places which had not been contaminated by sewage or in any other way. These samples of soil were pulverized, placed in Erlenmeyer flasks and sterilized, after which they were inoculated with cultures of the typhoid bacillus. It was found that the Eberth bacillus grew luxuriantly in the polluted earth, and that flasks containing this soil showed active growths of this microorganism after the lapse of 105 days. The results obtained with the unpolluted earth were quite different. In these soils the germ not only failed to multiply, but after a short time it died out.

Investigations by Klein indicate that the process of nitrification as it goes on in soil, favors the growth and development of the typhoid

bacillus. Klein had ascertained, as others before him had done, that sewage is not a suitable medium for the growth of this bacillus, but subsequently he found that by the addition of nitrates to crude sewage the latter is converted into a more suitable medium for the growth of this organism. In fact, in this modified sewage the typhoid bacillus grows abundantly.

Robertson selected a grass-covered field for his investigations. Patches of turf were cut and removed from the subjacent soil. At one place the ground immediately below the turf was watered with the bacillus, after which the turf was replaced. In another locality 9 inches of the earth beneath the turf was removed and the Eberth bacillus sown at this depth; while in a third experiment the germ was placed at a depth of 18 inches, the soil, which had been removed, being carefully replaced after depositing the germ. One hundred and thirty days after this had been done the soil under the turf of the infected localities was removed and examined. Robertson found that in all cases the bacilli had not only retained their vitality, but had multiplied. In the locality where the germ had been placed 18 inches beneath the surface it had grown through the earth above it, where it was found widely and abundantly distributed. Some of these plantings were made in July, 1895. During the cold months of the following winter no typhoid bacilli could be obtained from the soil in which they had been deposited. During the following spring these spots were treated with dilute sterile broth in order to furnish material for the growth of the germ and, furthermore, for the purpose of rendering the conditions similar to those existing in cases of pollution with sewage. It was found in the following June, nearly a year from the time of the planting of the germ, that those localities which had been properly fertilized with the beef broth furnished an abundant crop of the germ, while areas which had not been so fertilized failed to show any growth.

These experiments indicate that a polluted soil when once infected with the typhoid bacillus may retain the infection for a long time, and they are quite in accord with military experience, inasmuch as it has frequently been found that a healthy regiment may speedily develop this disease after occupying a site vacated by an infected command. The history of typhoid fever among the troops during the war of the rebellion furnishes instances of this kind, one or two of which may be mentioned.

The Twenty-third Massachusetts, numbering 900 men, left Massachusetts in November, 1861, and were encamped at Annapolis, Md., until January 8, 1862, the record of health being good during this time. The regiment arrived at Roanoke Island February 7, 1862, from whence it embarked to Newbern, N. C., arriving at this place March 14, 1862. According to the report of the regimental surgeon, George Derby, the health of the regiment, in spite of exposure to many

hardships, had been good. Arriving at Newberne the regiment occupied an encampment, including tents, abandoned by a Confederate regiment that had suffered severely from typhoid fever. The disease soon appeared among the men of the Massachusetts regiment (the number of days before the appearance of the first case is not stated), and during the month of April, 1862, 300 cases developed and 22 deaths occurred.

On March 7, 1862, the Tenth New York Cavalry moved into barracks at Perryville, Md., which had recently been vacated by the Fourteenth U. S. Infantry. The latter regiment had suffered largely from typhoid fever during the month of February, 1862. The barracks were thoroughly cleaned, drains opened and improved, and an excellent spring, which was exempt from any source of pollution, was found. The Fourteenth Infantry had used water from a well only 6 feet deep and this had been supposed to be the source of the typhoid fever. Notwithstanding the precautions taken by the New York regiment, diarrhea and so-called malarial fever soon appeared. On March 26, 1862, the New York regiment was moved across the bay to Havre de Grace, and the following morning numerous cases of so-called remittent fever reported at sick call and soon diarrhea became epidemic in the command. The monthly report of sick and wounded for April shows 28 cases of remittent fever and 2 cases of typhoid fever. It can hardly be doubted that all these cases of fever were in reality typhoid, and that they were contracted through the occupancy of an already infected locality.

The following illustrates British experience in India bearing on this point: In January, 1890, a battalion of a South Wales regiment occupied a certain site at Bareilly, and while there suffered severely with typhoid fever. On account of this outbreak this battalion was moved to another location. In the following November a battalion of the Royal Munster Fusiliers came to Bareilly and was located on the spot occupied by the South Wales regiment nine months before. Within three weeks after occupation of this locality by the Fusiliers cases of typhoid fever began to develop. After consultation it was decided to move the camp 1¼ miles farther west; when this was done the epidemic abated.

That the floors, furniture, and bedding of barracks may become infected with typhoid fever and may continue to endanger the life and health of its occupants for a long time is abundantly shown in the records of military surgeons. The following report by Chour, a Russian medical officer, is an instance: A typhoid epidemic appeared in two infantry regiments garrisoned at Jitomir. All the soldiers of these two regiments obtained their drinking water from the same source. One regiment had in 1885, 9.6, and in 1886, 3.2 per mille cases of typhoid fever. The second regiment had during the same time a similar proportion of cases, but in one company of the second regiment

14 out of 90 men were stricken with typhoid fever. The extraordinary number of cases of this disease in this company led to the supposition that the part of the garrison occupied by these men was specifically infected. In December, 1886, the room occupied by this company was vacated and subjected to thorough disinfection. The walls, the floor, and the furniture of the room, also the clothing of the soldiers, were disinfected. After this had been done this company was allowed to return to its own quarters. In 1887 the number of cases of typhoid fever in this company was reduced to 1.7 per mille, and in 1886 there was not a case. However, during the same time, typhoid fever increased among the soldiers occupying parts of the garrison which had not been disinfected. The disappearance of the disease among the soldiers that occupied the disinfected quarters and its persistence and increase among the soldiers in the undisinfected quarters led Chour to conclude that the typhoid bacillus was disseminated through the dust in the rooms. It may be that the bedding and clothing of the soldiers were soiled with typhoid stools, and the bacilli may have been transferred from these soiled articles to the alimentary canal by means of the fingers, or it is possible that the dust from the infected clothing carried the specific bacillus through the air which was inhaled by the occupants of the room. This and other equally striking instances of garrison infection show the necessity of thorough disinfection of quarters infected with typhoid fever.

It will be seen from the above that both experimental evidence obtained with pure cultures of the bacillus and epidemiological observation in the study of typhoid fever show that infected things and places may remain sources of danger for weeks and months. These facts have not been sufficiently impressed upon the medical profession, and the necessity of thorough disinfection of soiled clothing and bedding, etc., has not been appreciated. The history of outbreaks of typhoid fever among our soldiers, as detailed in this report, will emphasize the necessity of giving more attention to disinfection after typhoid fever.

Since epidemics of typhoid fever are frequently spread by means of drinking water, the longevity of the bacillus in this medium is of considerable importance. Many experiments have been made for the purpose of obtaining information on this subject. Evidently the conditions influencing the life of the bacillus are not likely to be identical in any two sources of water supply. In distilled water and sterilized drinking water obtained from springs, wells, rivers, and lakes, and kept at ordinary room temperature without exposure to direct sunlight, the typhoid bacillus may rapidly multiply and may retain its vitality for three or four months. Exposure of infected water in shallow vessels to direct sunlight hastens the destruction of the bacilli. A like effect is produced when the water is frequently and violently agitated. In ordinary unsterilized water the conditions that influence

the life of the typhoid bacillus are many and varied. In the first place, the chemical composition of the water is not without effect upon the longevity of the typhoid bacillus. As has already been stated, sewage ordinarily does not form a good medium for the growth of this germ, but, as Klein has shown, the addition of nitrates renders the growth abundant, and that processes of nitrification are constantly going on in polluted water is shown by the presence of nitrites and nitrates. Evidently the kind and number of other germs present in a foul water have much to do in determining the longevity of the typhoid bacillus in such mixed cultures. Some of the ordinary water bacteria undoubtedly hasten the death of the bacillus, owing to the fact that the conditions of growth are more favorable to the former than to the latter. However, experimental evidence on this point is not always conclusive, because the water bacteria are present in relatively much greater numbers than the typhoid bacillus, and failure to detect and isolate the latter is not always convincing proof of its absence. In fact, the detection of the typhoid bacillus when added in small amount to a large volume of water containing numerous germs of different species is by no means an easy task, and so far as the detection of this organism in natural waters suspected of having caused typhoid fever is concerned, it is doubtful whether anyone up to the present time has succeeded in isolating from such water a typical Eberth bacillus. It is not to be inferred from this that the typhoid organism is not present in such waters, but the difficulty lies in its separation and specific identification. Moreover, it is altogether probable, indeed we may say quite certain, that after the Eberth bacillus has grown for several generations in water it shows cultural variations from the typical bacillus obtained from the spleens of persons dead from typhoid fever.

Westcott[1] reports a case of apparently great longevity of the typhoid bacillus in water. He states that he was able to trace 19 cases of typhoid fever to a well drawing its supply from a sewage-contaminated area. On closing the well the epidemic ceased, but on reopening it for the purpose of obtaining water for laundry purposes another case occurred. The well had been closed twenty months, and during this time the conditions were such that the introduction of further contamination was improbable.

The belief that commercial table waters are always safe is by no means justified. Many of these are ordinary waters taken from diverse sources and charged with carbonic-acid gas. In such a water the typhoid bacillus may retain its vitality for a long time. It must be evident that the purity of a commercial table water depends upon its source and the care and skill exercised in handling it. It may be remarked here, parenthetically, that some of the commercial waters

[1] Westcott, Journal of State Medicine, vol. 7, p. 104.

sent to Sternberg Hospital, at Chickamauga, in 1898, contained a sufficiently large number of germs to condemn their use. In fact, they contained more germs per cubic centimeter than the waters obtained from springs and wells in and about the park. We do not mean to say that the typhoid bacillus was found in any of these commercial waters, but we do mean to say that they were too filthy to be used as drinking water.

In certain liquid foods, such as milk, bouillon, and broth, the typhoid bacillus may retain its vitality for months. This is true whether the food be sterilized or unsterilized at the time of the introduction of this organism. When deposited on solid food, such as potatoes, bread, and meat, the typhoid bacillus may retain its vitality as long as such foods are likely to remain palatable. In other words, this bacterium, when deposited on such foods, may retain its virulence until putrefactive changes become markedly advanced. We will return later to a discussion of the spread of typhoid fever through infected articles of food.

Since the Eberth bacillus forms no spores, it is easily destroyed by a sufficiently high temperature. In boiling water it is instantly killed, and a like result is obtained by a ten minutes' exposure to a temperature of 60° C. Low temperatures prevent multiplication, but do not destroy the bacilli. They may remain frozen in ice for months without appreciable loss in vitality or virulence. Furthermore, alternately freezing and thawing of cultures of this bacillus repeated indefinitely are apparently without effect. The evidence that certain small epidemics of typhoid fever have been due to infected ice is quite positive.

From the preceding statements it must be evident that the typhoid bacillus is capable of retaining both vitality and virulence for months after it has been discharged from the body. Not only is this true, but it may multiply both in the soil and in water.

THE DISSEMINATION OF TYPHOID.

(*a*) Transported by man.

Man himself is the most active agent in the dissemination of this disease. He may carry the specific virus in his alimentary canal, on his person, or in his clothing. In this way the germs of the disease may be carried hundreds and thousands of miles and may be widely distributed. An infected recruit may plant the specific bacillus of this disease in every latrine in his regiment before he is suspected of having the disease himself. So widespread is typhoid fever that in assembling a regiment of volunteers it may be assumed that among these men there are one or more infected with this disease. Practically, typhoid fever is always imported into military camps, and having been thus introduced it too frequently finds conditions favorable for its spread.

In the history of the war of the rebellion there is but little information concerning the importation of typhoid fever, more attention being given to general reports concerning hard service, inclemency of the weather, and insanitary conditions in camp as connected with the prevalence of this disease. More importance is attached to exposures, hardships, the unaccustomed mode of life of the young soldiers, overcrowding and bad ventilation, than to importation of the disease from the localities where the men were recruited, although this is occasionally suggested. The absence of special reports on the causation of typhoid fever in the camps was attributed to the difficulties attending an investigation into the origin and transmission of this disease, owing to the existence of unknown and unsuspected factors.

When the Franco-German war began every corps of the German army was infected with typhoid fever, and the second division of the Eleventh Corps was having at that time a marked epidemic of this disease. The following figures show the number of cases of typhoid fever in each corps of the Prussian army on June 15, 1870:

	Number of cases.	Rate per thousand.		Number of cases.	Rate per thousand.
General Corps	23	1.3	Sixth Corps	29	2.1
First Corps	18	1.3	Seventh Corps	17	1.2
Second Corps	7	.51	Eighth Corps	16	.93
Third Corps	10	.68	Ninth Corps	10	.67
Fourth Corps	6	.42	Tenth Corps	22	1.6
Fifth Corps	9	.68	Eleventh Corps	41	3.0

The infection was not confined to the Prussians, but extended to every contingent of the German army. The seeds of the disease carried with them rapidly bore fruit, especially among the troops besieging Metz and later among those besieging Paris. Within less than two months after war was proclaimed, typhoid fever had extended so widely among certain divisions of the German troops, notably in the Eleventh Corps of the Prussian army and in the Wurtemburg division, that more than 15 per cent of the men of these commands were sick with this disease. The total number of cases among the under officers and men in the German army during the Franco-German war amounted to 73,396, which is equivalent to 9.31 per cent of the average strength of the army. It will be remembered that the invasion of France began about the middle of July, 1870. During the second half of this month the total number of cases in the German army was 345, less than the average for preceding years of peace. In August the number perceptibly increased, amounting to 2.6 per thousand, but this was not sufficient to cause any alarm, and up to the beginning of September it could not be said that there was an unusual prevalence of this disease. However, early in this month there was an explosive outbreak and the cases ran up to 12,463, which was equivalent to 15.3 per thousand. October showed 17,253 new cases. In this month the epidemic reached

its climax, fell slowly until January, 1871, and more rapidly to June, but at the last-mentioned date it had not reached the peace level. During the fall of 1870 there was not a regiment in the German army free from typhoid fever. In addition to the importation of typhoid fever, the Germans invaded a country in which this disease was then and is at all times practically endemic. However, the point which we wish to emphasize here is that the invading army transported typhoid fever with it, and that from seeds thus carried the disease spread until no regiment remained free from it.

Typhoid fever may be transported along with an army into regions where man has never previously been. This was illustrated in the Afghan war, from 1878 to 1880. Several of the encampments of the English soldiers during this invasion of Afghanistan occupied positions probably never before occupied by human beings. It is not at all likely that the water, which was obtained from mountain streams in the invaded region, was specifically contaminated with the virus of typhoid fever; nor was it likely that the virgin soil covered by these encampments was infected, except as it became so by occupation, and yet typhoid fever occurred at nearly every station occupied by the English troops. Only one explanation of the prevalence of this disease in these places seems possible. It is known that the English troops which had been encamped in various parts of India were widely infected with typhoid fever when the invasion of Afghanistan was begun. A similar experience is furnished by the history of French expeditions in northern Africa. In the Oran campaign in 1885 French commands encamped in desert stations never before occupied, and in these typhoid fever not only appeared, but acquired epidemic proportions.

In the Suakin expedition of 1885 every precaution was taken to insure a pure water supply for the troops. In fact, all the drinking water was distilled. Notwithstanding this fact typhoid fever prevailed quite extensively. At least one regiment, the East Surrey, joined the expedition already infected with typhoid fever. It is more than likely that these men infected the latrines and that flies aided in the distribution of the disease.

In the expedition for the relief of Chitral, from March 28 to August 24, 1895, typhoid fever was carried along with the English soldiers. The first recognized case of this disease occurred April 29, although this had been preceded by several other cases the diagnosis of which had been doubtful at the time and which had been transferred to base hospitals, proving later to be typhoid fever. The expedition consisted of two regiments, with a total strength of 1,601 officers and men. After battles at Malakand and Kahr, April 3 and 4, these regiments were encamped at Kahr, in the Swat Valley, 2,000 feet above sea level. The health was good at first, but with the increasing heat the men, who were very much crowded together in small single fly tents,

began to suffer from malarial fever, and typhoid fever soon made its appearance. From April 29 to August 4, the time of the arrival of the expedition at Laram Kotal, 172 cases, with 39 deaths, were reported. In regard to this epidemic, Surgeon Major-General Mansell makes the following statement:

The first case * * * on April 29 was probably imported from India. Once the disease was introduced into such camps as the troops occupied first at Kahr, and later on at Laram Kotal, and bearing in mind the predisposing influences of climate and other conditions of the former place in May, when the men were inactive, the hard work they subsequently underwent road making, the gradual fouling of the soil through the extension of latrine trenches, the inadequate conservancy arrangements due to the want of a sufficient establishment, it is not difficult to account for the rapid spread of the disease. The milk and bazaar supplies were, of course, liable to suspicion, but both were under strict supervision, and the outbreak can not, in my opinion, be attributed to them. The water supply, which was bad at Kahr, may also be disregarded as the cause, as when the troops moved to Laram, where the supply was excellent, the epidemic increased in virulence. I attribute the disease to the fouling of the ground, inevitable in camps, the lack of sufficient conservancy establishments, the contamination of food, etc., through the agency of dust and flies, and the necessary crowding, dirt, and intimate contact in which the men lived, often I think carrying the infective germ from one to another. The absence of these last conditions goes far to explain the remarkable immunity from the disease that the officers enjoyed.

When the English invaded Egypt in 1882, some of the regiments which had been withdrawn from Mediterranean stations, and which constituted a part of the army of invasion, were infected with typhoid fever before leaving their stations. Soon after disembarking at Ismailia occasional cases of typhoid fever began to appear. The disease was at first diagnosed remittent fever, but as it did not yield to quinine in full doses, two autopsies were held, and these showed the lesions of typhoid fever. From Ismailia the disease accompanied the troops until the army took up its permanent camp at Cairo, at which place it culminated in a serious epidemic. The camp sites of the several regiments were situated on sandy soil and were some distance apart, and the latrines were easily dug and regularly filled up; frequent inspection failed to show any sanitary defect. All excreta from fever patients, as well as bedding and clothing used by them, were at once disinfected. The excreta were deposited in a special pit; all the water was boiled and filtered. Notwithstanding this, many of the hospital corps men contracted the disease in removing the excreta of patients. On the march from Ismailia to Cairo the troops drank canal water; but that this water did not occasion the epidemic appears to be borne out by the immunity from typhoid fever enjoyed by the Indian contingent and the Seaforth Highlanders, although using the same water. The Manchester regiment also, which garrisoned Ismailia—the termination of the canal—and used this water, had only one case. The Household Cavalry and the Fourth Dragoon Guards which were in the desert during the whole of the campaign,

having hard work, suffering much exposure, drinking bad water, and living in insanitary camps, suffered comparatively little. The Seventh Dragoons and the Nineteenth Hussars remained long in camp at Cairo and suffered greatly, the disease being most prevalent among them during the months of November and December.

According to Surgeon-Major Tarrant, the epidemic of typhoid fever which prevailed among the English and native troops in the Zulu war (1878–79) was imported into Fort Pearson from Thring's Post and Saccharine. In regard to the same epidemic, Major Hodgson states:

> Numbers of men came from Fort Chelmsford with remittent and simple continued fever, of which a large portion proved to be enteric. In a general way, though a large proportion of the fevers were returned as simple continued, my impression is that nearly all of the cases were enteric of the milder or more severe type. From such inquiries as I was able to institute, I concluded that enteric fever was originally brought from Durban and was carried by the troops to the various stations where it broke out, and that in all cases it was aggravated by the gathering together of a large number of men and cattle, and the insanitary state which always accompanies such conditions.

The history of mining expeditions also gives us instances of the transportation of typhoid fever to places far remote from the permanent habitations of man, as is illustrated by the epidemic at Dawson City, on the Yukon, in January, 1899. Indeed, the history of this disease justifies us in stating that wherever and whenever men congregate and live without adequate provision for disposing of their excrement, there and then typhoid fever will appear. This seems to be so universally true that many men who have been engaged in the study of the epidemiology of this disease have come to agree with Murchison in his pythogenic doctrine concerning the origin of this disease. This theory supposes that typhoid fever may be generated independently of a previous case by the fermentation of fecal and other forms of organic matter. This conclusion results from the difficulty generally experienced in tracing the introduction of the disease. To this point we have given especial attention in our report, and we have traced typhoid fever into every encampment in which it became epidemic and, as already stated, man himself is the most active agent in the dissemination of this disease. It is he who carries the specific virus about his person into all congregations of men. He deposits this virus in his excrement, and it is thence distributed in various ways among his fellow-men.

(*b*) Dissemination of typhoid fever through the air.

Is typhoid fever ever disseminated through the air? This is a question to which diverse answers have been given. Our present knowledge of the etiology of this disease gives no support to the old belief that it may be caused by the inhalation of gases from decomposing organic matter. In the first place, infection can result only from the specific germ, and no amount of decomposing matter in which this

organism is not present can cause the disease. In the second place, the specific cause of typhoid fever is a particulate body and not a gas. Inhalation of gases from putrid material may cause intoxication, but not infection. Many of the cases reported by older writers, in which typhoid fever was believed to be due to the inhalation of gases from putrid matter, were, as we can now see, not instances of infection. As an illustration of this, we may mention the Clapham epidemic as reported by Murchison. Twenty out of twenty-two schoolboys, who watched the opening of a pit that contained a large amount of decomposing organic matter and which had been closed for some years, were within three hours prostrated with vomiting and diarrhea. Two died, one within twenty-three and the other within twenty-five hours. Post-mortem examination showed acute swelling of Peyer's patches and the solitary follicles with slight ulceration of these structures, together with congestion of the mesenteric glands. These were diagnosed as cases of typhoid fever, but we now know that they were instances of acute poisoning with noxious gases. In the third place, the typhoid bacillus is generally destroyed by other germs or their products in material sufficiently advanced in putrefaction to give off unpleasant odors. The oldest cultures of the bacillus are free from disagreeable smells, and infection with typhoid fever is not likely to result from ingestion of putrid matter. Unfortunately, there is nothing about food or drink infected with this germ to indicate to the unaided senses the presence of such infection. Water containing the typhoid bacillus may be clear, sparkling, and of pleasant taste. Milk infected with this micro-organism reveals no peculiarities either to taste or sight. A fly may deposit typhoid bacilli upon a cooked potato without rendering this article of food less palatable to the consumer. We wish to emphasize the difference between the question now before us as to whether or not typhoid fever may be disseminated by infected particles of dust carried through the air and the older idea that it was spread by the agency of gases given off from putrid material. Such gases are generally germ free. In fact, we may state as a bacteriological axiom that gases given off from putrefying organic matter contain no germs. Certainly this is generally true, and we know of no exception. On the other hand, a wind may carry partially dry infected particles of dust which may be deposited on food or inhaled and cause typhoid fever. However, we are reaching a conclusion before stating arguments. The question is whether or not typhoid fever may be disseminated through the air. Recently, Germano has collected the literature bearing upon this question and has also added experimental data of his own. We will give a brief summary of the statements made by this author and see what conclusions he has drawn therefrom and whether or not we can agree with him in these conclusions.

In reviewing the literature of air-borne typhoid fever, Germano

first cites the article by the Russian military surgeon, Chour, concerning the garrison at Jitomir, to which we have already referred. We have pointed out that Chour's conclusion that the typhoid bacillus was disseminated through the dust in the rooms of the garrison is not altogether justified. It may be that the bedding and clothing of the soldiers were soiled with typhoid stools, and the bacilli may have been transported from these soiled articles to the alimentary canal by means of the fingers. Of course it is possible that the dust from the infected clothing, or that deposited on the floor, walls, or furniture, did carry the specific bacillus through the air which was inhaled by the occupants of the room. Certainly it must be admitted that the report of this epidemic is of value and shows the necessity of the thorough disinfection of quarters infected with typhoid fever; but it does not furnish positive proof that the infection was carried through the air.

The second citation by Germano is a report by Favier. On August 26, 1886, a regiment of dragoons in which there had been no typhoid fever, left Compiegne for the annual maneuvers. From the above-mentioned date until September 6 of the same year one-half of this regiment was quartered at the village of Cuvilly, while the other half was divided between Neuville and Ressous. On the last-mentioned date the troops reunited at Compiegne. On September 11 a dragoon who had been quartered at Cuvilly was taken with typhoid fever. From this time up to October 2 of the same year 8 other cases appeared in this half of the regiment, while only 2 cases appeared in the other half, and the first of these had its initial date October 5. Investigations show that during the stay of the troops at Cuvilly there were 3 cases of typhoid fever in a family at that place. The soldier who first contracted typhoid fever had been quartered in this house, and the next 2 cases to develop this disease were men who had visited this house. Fevier concludes that typhoid fever was spread in these cases through the air. He thinks that the man quartered in the infected house at Cuvilly received the infection through the air inhaled at that place, and that the soldiers visiting this house were infected in the same way, and that the disease spread to the half of the regiment which had not been at Cuvilly through the air. It seems to us that this conclusion is by no means warranted in any of these cases—at least such a conclusion does not necessarily follow from the facts as stated above. The soldier quartered at the house of the sick may have been infected by personal contact with the sick, through his drinking water or through his food. All of these possible methods of infection are also applicable to the men who visited this house. These men may have carried the infection in their clothing or on their persons to their comrades who had not visited the house. When the halves of the regiment were united in the common barracks at Compiegne, common drinking cups may have become infected by personal

contact and may account for the spread of the disease. For these reasons, we are inclined to reject this report as evidence that typhoid infection may be disseminated through the air.

The third report cited by Germano is equally unsatisfactory. Ollivier states that a girl sick with typhoid fever was placed in a hospital ward in which there were no other cases of this disease. Soon thereafter two other patients in the same ward developed typhoid fever. One of these occupied the bed by the side of the first patient and the other a bed opposite. In order to prevent further dissemination of the disease, the ward was vacated and thoroughly disinfected. The disinfection of the ward was certainly justified, but the conclusion that the disease was spread through the air is by no means warranted. It is more than probable that attendants carried the germs on soiled fingers from one patient to the other. The history of these cases teaches, as similar instances likewise indicate, that it is not safe to place typhoid-fever patients in a ward occupied by those suffering from other diseases; or, in other words, it teaches the desirability of the isolation of typhoid cases, but certainly it furnishes no positive proof that typhoid fever may be disseminated through the air.

Lecuyer describes a small epidemic of typhoid fever in Vassognes, in which village there had not been a case of this disease for several years. The corpse of a woman who had died from typhoid fever at Rheims was brought to Vassognes for burial. The body had not been embalmed and was transported in a simple wooden coffin and at the time of burial was in an advanced stage of decomposition. A few day later, three children of the dead woman came from Rheims to Vassognes. These soon sickened with typhoid fever, and the disease spread until it had infected many other persons in the village. The author concludes from the fact that Vassognes had long been free from typhoid that the germs were disseminated through the air. His conclusion that the water of the village was not the source of infection is justified, but his belief that the disease was spread through the air is only an assumption. Soiled hands and clothing were more likely factors in the spread of the infection.

Dewolz reports certain cases that occurred at Eaux Bonnes. In July, 1886, a woman from Paris came to a hotel in this village, where she soon developed typhoid fever. The disease ran a normal course, and terminated after four weeks in recovery. A short time after this, three daughters of the proprietor of the hotel were taken sick with typhoid fever. Beyond these cases the epidemic did not spread. Before the coming of the woman from Paris there had been no case of typhoid fever in the village. Bacteriological examination of the drinking-water supply showed it to be of unquestionable purity. The air of the room occupied by the girls communicated through a covered passage with that of the sick chamber of the woman. Moreover, the door of the privy in which the dejections of the sick woman were

thrown, without disinfection, opened into the same passage. The author concludes that the disease germs were carried through the air. This conclusion does not necessarily follow. It may have been that those attending the sick woman handled the food of the children without disinfecting their hands.

Passing over a number of other reports collected in the review of the literature by Germano, we come to that of Froidboise. The military station of St. Bernard lies about 2 miles south of Antwerp and 1,800 meters from the point where the Rupel flows into the Schelde. Usually there are four regiments of infantry located at this place. For three years there had not been a case of typhoid fever among the soldiers in these barracks, when in August, 1892, a severe epidemic appeared. The initial date of the first case was August 22 and of the last case October 20. The water supply was not changed nor were the barracks disinfected. The explanation given by Froidboise is as follows: On account of some engineering work which was being done in the Schelde at the mouth of the Rupel, the latter stream overflowed its left bank and distributed a large amount of sewage brought down from Brussels and Mechlin. The receding water left a thin deposit scattered over several thousand acres of land. As this deposit consisted of sewage from Brussels and Mechlin, it is more than likely that it contained the typhoid bacillus in large numbers. As has been stated, the epidemic began August 22 and ended October 20. From August 12 until October 10 the direction of the prevailing wind was such that it would carry the dust from the drying deposit toward and into the garrison. Before and after the dates mentioned above, the wind was in the opposite direction. It seems to us that this is the most interesting report among those collected from medical literature by Germano. As has been stated, the water supply to the soldiers in the barracks was not changed before, during, or after the epidemic. Neither could the disappearance of the disease be attributed to disinfection, because this was not practiced. The question is whether or not the typhoid bacillus can be carried in particles of dust suspended in the air through a distance of 1,800 meters. Germano concludes that this is impossible, but we will return to this question later.

Germano quite properly divides the above-mentioned and similar reports collected by himself into three groups. In the first group he places those instances in which it was probable that the disease was disseminated by direct contact with the sick, leading to soiling of the hands or clothing with the infected dejections. In the second group, he thinks that indirect contact through persons with soiled hands or through infected clothing or bedding or other agents is a more likely explanation than dissemination through the air. As an instance of cases coming in the second group we will give one reported by Gielt. A man while away from home contracted typhoid fever and returned to his native village, in which there had not been a case of this dis-

ease for a long while. The undisinfected feces from this man were thrown upon a dung heap. Some weeks later 5 men carted away this material and later 4 of these developed typhoid fever and the fifth suffered from intestinal catarrh, accompanied by enlargement of the spleen. The undisinfected dejections from these men were thrown upon another dung-heap. A few months later 2 men removed this material, and of these 1 developed typhoid fever. Brouardel, who reported these cases for Gielt, supposes that the typhoid bacilli were disseminated through the air from decomposing dung heaps. Germano thinks it more probable that the men engaged in this work soiled their hands and in this way transferred the bacilli to their mouths. This is highly probable, but certainly we can not positively state that particles of dust were not inhaled by the men who were engaged in loading and unloading the infected material. In order to arrive at any opinion concerning the probability between the possible avenues of infection in these cases, we would have to know more than we do concerning the amount of moisture in the material when it was removed and the strength of the wind prevailing at the time. In the third group Germano places those cases in which the germs are supposed to be disseminated through the air, because no other explanation seems probable; but he states that in many epidemiological investigations the cause of the spread of the disease remains unknown, because we can not ascertain all the conditions.

After reviewing the literature as stated above, Germano endeavors to decide the question concerning the possible dissemination of typhoid bacilli through the air experimentally. In his investigations he finds that typhoid bacilli mixed with dust from different sources and thoroughly desiccated speedily dies, and he concludes that air infection through many hundred meters, as supposed by Froidboise in the cases that occurred in the military garrison near Antwerp, is impossible. In our opinion Germano's experiments confirm what was already well known, that the typhoid bacillus is speedily deprived of life by desiccation, but they do not convince us that dissemination of the living germ in particles of partially dried dust may not be carried even distances of several hundred meters and deposited upon the food, in the drinking water, or inhaled.

More recently, Neisser has shown that dust infected with the typhoid bacillus may be carried by a current of air moving at a rate of 1.7 centimeters per second through a distance of 680 centimeters and there deposited with the germ, still possessed of vitality. However, he concludes that since this germ is not transported to a distance of more than 680 centimeters by the air moving at a rate which generally prevails within a room, that typhoid fever can not be considered a dust disease, but is nearly so. It will be seen that this conclusion has reference only to the possibility of the typhoid bacillus floating through the air of a closed room; but even within doors the air often

moves with a velocity many times greater than 1.7 centimeters per second. Especially is this true when the movement of the air within the room is influenced by drafts from windows, doors, and ventilating flues. Thus we find that there is a possibility of typhoid infection from the inhalation of the air of a room in the dust of which the specific bacillus of this disease exists. Partially dried typhoid stools on the floor may be sufficiently comminuted to form an infected dust, which may float through the air, be deposited on food, find its way into uncovered receptacles of water or milk, or be directly inhaled, find lodgment in the nose and pharynx, and finally reach the intestines.

While all of this is possible within a closed room, the danger of air infection with typhoid fever must be greatly increased in military life, where food and drink are often exposed for hours to an atmosphere laden with dust, possibly infected with the typhoid bacillus. As we shall have occasion to state later, the surface of the ground about many of the regimental encampments at Chickamauga in 1898 was so covered with fecal matter that it was impossible to walk through those places without soiling the feet. So prevalent was typhoid fever at Chickamauga that much of this fecal matter must have contained the Eberth bacillus, and it seems hardly possible that the great clouds of dust in which the men lived could have been free from this infection. The shell roads through the encampments at Jacksonville were ground by the heavy army wagons into an impalpable dust several inches thick. Along these roads scavengers carted in half barrels fecal matter containing the typhoid bacillus. The contents of these tubs frequently splashed over and fell in this dust. On each side of these roads soldiers were encamped, and many mess tables were in close proximity to the roads. Local whirlwinds sometimes caught up large quantities of this dust and carried it considerable distances. After seeing these things, we feel that we can not exclude the dust as a probable carrier of the typhoid infection, notwithstanding the fact that it would probably be a very difficult thing to scientifically demonstrate that the disease was disseminated in this way.

(*c*) The influence of the soil in the dissemination of typhoid fever.

There is an old and widespread belief that many of our ills come from the soil, and man has always been inclined to attribute his misfortunes to locality. That this idea has not disappeared is shown by the fact that many of the soldiers encamped at Chickamauga in 1898 repeated the story that the name of the place is an Indian word meaning "river of death," and that the locality was naturally an unhealthy one. Furthermore, that some of the surgeons shared in this belief in the special virulence of the locality was evidenced by the fact that they designated the continued fevers that developed among the soldiers as "Chickamauga fever," and claimed that it was different in many

respects from any fever known elsewhere. Of course, it is true that there are unhealthful localities, but the most salubrious place can be rendered unfit for human habitation when soiled by the excretions of man. As we shall see later, the surface of Chickamauga Park did become largely contaminated, and the locality certainly was, in the late summer of 1898, an unhealthy one, but this was not due to natural conditions, and there is not the slightest evidence that the soil of this locality is naturally productive of typhoid fever. Had the same troops been encamped in the most healthful spot in the world, and had they shown the same disregard of camp sanitation, there is no reason for believing that they would have fared any better than they did in Chickamauga Park, which is in truth naturally a most salubrious locality.

There is an old theory concerning the relation of the soil to the causation of typhoid fever which still has many advocates. This theory supposes that decomposing organic matter in the soil passes through a ripening process by means of which the typhoid poison is either generated de novo or is greatly increased in virulence. Reference has already been made to the pythogenic theory of Murchison, and this, in a more or less modified form, has been accepted and is advocated by many prominent epidemiologists, especially those with military experience. It is believed that different soils vary in their adaptability to harbor, grow, and ripen this poison. The believers in the pythogenic doctrine are divided into two groups: (1) Those who hold that soil contaminated with any fecal matter will generate the typhoid poison; (2) those who believe that the introduction of the specific bacillus is necessary, but that this undergoes a ripening process in the soil by means of which its virulence is greatly augmented.

Scientific support of the theory of the ripening of the typhoid poison in the soil has been found by the investigations of Pettenkofer into the etiology of typhoid fever in Munich. During the first half of the present century typhoid fever was continuously endemic in Munich. This city is situated on a bed of gravel and marl, and during the time mentioned fecal matter was deposited in pits and allowed to percolate into the soil from which the drinking water, collected in shallow wells and surface springs, was taken. With our present knowledge of the etiology of this disease we would suppose, with the above-mentioned conditions existing, that the drinking water was specifically contaminated. However, Pettenkofer, from his very careful studies of the distribution of the disease, came to the conclusion that its prevalence was not due to contaminated water. After many years of careful and skillful investigation, he found that the prevalence of typhoid fever varied inversely with the height of the ground water under the city. The nearer the ground water came to the surface, the less typhoid fever; with the fall of the level of the ground water the number of cases of typhoid fever increased. He concluded from this

that the deeper layers of the soil contained putrefactive material in which the typhoid-fever poison undergoes a ripening process, and that the ripened germ passes from the soil into the air and is inhaled by susceptible persons. When the level of the ground water is high, the putrefying material in which the ripening process is supposed to be going on is covered by the water and its escape into the air is prevented, while a fall in the ground water leaves the putrefying substances uncovered and the poison passes into the air. It will be seen from these statements that Pettenkofer believes that the specific poison must be present, but that this undergoes in the soil changes by means of which its virulence is augmented. If this theory be true, it should hold good for other cities as well as for Munich, and numerous investigators have found that elsewhere this supposed relation between ground water and the prevalence of typhoid fever is by no means constant. Indeed, there are so many exceptions to Pettenkofer's rule concerning this relationship between the level of ground water and the prevalence of typhoid fever that this theory must be abandoned as an explanation of the origin of epidemics of typhoid fever. There is no reason for believing that in the ordinary movements of the air from the pores in the ground to the atmosphere the velocity is sufficient to carry dust laden with bacilli. Certainly, such a transference of the bacillus from the deeper layers of the soil to the atmosphere in the form of dust must be of most exceptional occurrence, if it ever happens. It might be stated in this connection that some sanitarians accept that part of Pettenkofer's theory which provides for the ripening of the poison in the soil, but believe that the ripened and highly virulent bacillus finds its way into the drinking water and does not infect through the air.

(*d*) The dissemination of typhoid fever through drinking water.

There can be but little doubt that in civil life the great epidemics of typhoid fever are generally caused by the specific contamination of drinking water. The danger in infected water was recognized long before the discovery of the specific bacillus and, indeed, epidemics had been unquestionably traced to contaminated water supplies. We have already seen that this micro-organism may live and multiply in water. The most frequent contamination of drinking water with typhoid material results from the introduction into the water of the feces or urine of some infected person. After this has happened, the rapid multiplication of the organism in water permits the speedy infection of a large volume. Moreover, in flowing water the specific bacillus may be carried considerable distances. Variations in the temperature of this medium do not affect the virulence of the germ. It may be frozen in ice and remain in this condition quite indefinitely without any loss in potency, and it is equally unaffected by alternate freezing and thawing. The specific contamination of drinking water may be responsible for isolated cases and for both small and large

epidemics. The infection of a farm well may lead to one or more cases, according to the number of susceptible people who drink from this source. Village epidemics may be due to contamination of the public water supply or that of some popular well or spring. In large cities epidemics involving hundreds and possibly thousands of cases may result from the contamination of the water supply at some point nearby or distant, as the case may be, from the city.

The fact that typhoid fever is frequently disseminated through drinking water is so well known that it is not necessary to take up much space in giving instances. The epidemic at Plymouth, Pa., in 1885, investigated by a member of this board, may be briefly referred to. At that time the population of Plymouth numbered about 9,000. The epidemic appeared suddenly, a maximum of 200 cases being reported in one day. Within a short time one-ninth of the population had been stricken with the disease. It was soon discovered that typhoid fever appeared only in those houses which were connected with the general water supply of the town. Houses whose inmates confined themselves to wells for their drinking water wholly escaped the disease. Thus it happened that in some parts of the city typhoid fever was present in nearly every house on one side of the street and did not occur in any house on the other side. The water supply of the town was obtained from a number of reservoirs fed by a mountain stream. On the bank of this stream, between two of the reservoirs, was a house in which there had been shortly before the outbreak of the epidemic a case of typhoid fever. This man visited Philadelphia late in December, 1884, and while there contracted typhoid fever. He returned to his home in January, 1885, and during his illness, which continued for many weeks, the undisinfected dejecta were thrown upon the snow within a few feet of the stream, or emptied into a privy standing on the hillside near the bank of the stream. Late in March the melting snow washed this infected material into the water supply and the first cases in the village appeared within three weeks of this time.

The epidemic at Iron Mountain, Mich., in 1887, investigated by another member of this board, furnishes some interesting points. At that time the population of Iron Mountain numbered about 6,000, consisting principally of miners. There were, all told, in the place about 1,000 houses, many of the dwellings being small and crowded. The village is situated in a valley extending north and south, and the lowest portion occupies a locality which was originally swampy. Upon each side of this village the hills are steep, and the greater part of the town lies upon the eastern slope. The soil is drift, consisting of sand and gravel, except in the lowest portions of the valley, where the drift is overlaid with vegetable mold. In some places the ledge of rock, which is of the Huronian strata, outcrops on the hilltops; in others, on the hillsides, and in others, in the valley. The drift is so porous

that within twenty-four hours after heavy rains the surface is dry. A portion of the village, numbering about 300 houses, had at that time a system of water supply, the source of which was a shaft 40 feet deep and far away from the contamination, to be referred to later. Those who drank exclusively of water from this source wholly escaped typhoid fever. The remaining portion of the village, the part in which fever prevailed, obtained its drinking water from wells sunk from 6 to 20 feet deep. There were no sewers or other means of removing filth. Privy vaults were used and slops and garbage were thrown into back yards and into the streets. A ditch, which conveyed the water from a mine to a small lake beyond the village, ran through this part of the town and was used by many as an open sewer. During the early summer of 1887 this portion of the village was exceedingly filthy; but notwithstanding this fact there were absolutely no cases of typhoid fever. In July a man sick with this disease was brought from a railroad construction camp to the village and placed in one of the houses highest up the hill, where he remained till he died. The undisinfected dejections from this man were thrown upon the ground about the house and into a privy vault in the yard. Rains evidently washed this material into the wells farther down the hill. In August a severe epidemic of typhoid fever appeared, and 350 cases were soon reported. In one house 13 of the inmates were striken with typhoid fever almost simultaneously. It should have been stated that although this village was exceedingly filthy in 1886, there was no case of typhoid fever during that year. The history of this epidemic indicates that filth, unless it be specifically contaminated, will not cause typhoid fever.

It is not always easy to determine how typhoid fever finds its way into a community. Indeed, it frequently happens that an epidemic of this disease breaks out in some isolated neighborhood without any evidence of its being brought into the place. Cases of this kind have led some to suppose that typhoid fever may originate de novo or that the colon bacillus present in normal feces may take on a specially virulent form, in which condition it may develop typhoid fever. The possibility of the conversion of the colon bacillus into the typhoid germ has been discussed elsewhere. It will only be necessary to state here that there are so many possible ways in which typhoid fever may find its way into almost any locality that it is not necessary to resort to any improbable theory in order to explain its occurrence at unexpected places. We have in mind an epidemic investigated by one of us a few years ago which may serve as an illustration. The village of St. Clair, Mich., a place of about 1,500 inhabitants, is located on the St. Clair River, and during the winter time is connected with the outside world by a spur from a railroad a few miles distant from the village. During the summer time St. Clair, on account of its location and its mineral waters, has its population multiplied several times, but after the close of navigation the number of strangers com-

ing to the place is small. In the spring of 1887 a most violent epidemic of typhoid fever suddenly burst out in this village. Within a few weeks more than 300 cases were reported. The village had its water supply from the St. Clair River, and the intake pipe extended out several hundred feet into the channel. A few private sewers or drains emptied into the river above the intake pipe, but the extension of the pipe far out into the channel, it was supposed, avoided any contamination from these sources. The most careful inquiry failed to give any history of an imported case of typhoid fever. That the disease was spread through the village by means of the drinking water did not admit of doubt. Only those who took their water from the village supply had the disease. Moreover, several farmers who came to town and drank of the village water developed the disease, while those members of their families who had not visited St. Clair remained unaffected. It was so plainly evident that the water was contaminated that the authorities determined to extend the intake pipe farther out into the river across a sandbar and to take the supply from the Canadian channel, but in preparing for this work it was found that the intake pipe was broken off near the shore and that the water was directly contaminated from the private drains mentioned above. There had been no case of typhoid fever in the houses from which these drains came. As soon as the pipe was extended and the water supply taken from the middle of the river the epidemic disappeared as suddenly as it had begun.

It might be inferred from this history, which is by no means unique, that pollution of the drinking water with normal fecal matter, or at least with that which did not contain the typhoid bacillus, caused the epidemic. However, this conclusion is not necessary. It is altogether possible for an individual to carry in his alimentary canal and eliminate therefrom the Eberth bacillus in virulent form without having the disease himself. The probabilities are that the majority of men who reach 40 years of age have at some time or another carried this germ in their bodies, and this may account for the fact that men of this age are less susceptible to the disease than younger men. It is also possible in the St. Clair epidemic that the infection came down the river from Port Huron, about 12 miles distant. Another possible explanation might be given by supposing that an individual who had recovered from typhoid fever recently, in visiting one of the houses above the intake discharged from his body into the drains the specific bacillus of typhoid fever. In some instances the typhoid bacillus continues to be eliminated with the urine for several weeks after recovery from this disease, and each cubic centimeter of such urine may contain millions of virulent bacilli. We say that these are possible explanations, and as long as we have no experimental evidence that the colon bacillus is ever converted into the typhoid germ, and inasmuch as we

do not know of such conversion among other micro-organisms, we are justified in thinking that such explanations as those suggested above are not to be overlooked.

From the statements already made it must be recognized that it is never safe to drink water contaminated, or which may possibly be contaminated, with human excrement, even when this comes exclusively from healthy people. We do not mean to say that water thus contaminated would always cause typhoid fever. In fact we have already given evidence that such water may be taken for a long time without giving rise to this disease, but there is always the possibility that even healthy persons may carry in their bodies for a while and then eliminate the typhoid bacillus in virulent form.

The question is sometimes asked whether or not the presence of the colon bacillus in water should condemn its use. We are not prepared at present to answer this question categorically. There are undoubtedly many varieties of the colon bacillus, and these not only differ in virulence, but come from diverse sources. A colon bacillus is found in the excretions of certain aquatic animals, and it is not probable that a few of these would injure man in any way. However, at present we can not distinguish between colon bacilli from turtles and fishes and those from man. Furthermore, we have no reason for believing that colon bacilli from man would cause typhoid fever, but the presence of this germ indicates contamination of the water supply with human excrement, and this condition is always dangerous to health and life. Even when the typhoid bacillus is present in water the colon bacterium is usually also present, and in such large numbers that the isolation and identification of the Eberth bacillus is exceedingly difficult.

There is danger of using an infected water in washing the hands, face, and other parts of the body. One of this board had an experience a few years ago illustrating this point. A certain family received its drinking-water supply from the city pipes, but as this water was slightly hard the members of the family used for ablution a soft water from a cistern, which was known to be wholly unfit for drinking purposes. The family consisted of father and mother, two sons and two daughters ranging in age from 14 to 21, and two roomers, young men of about 20 years of age. Every member of this household, except the father and mother, came down one after the other with typhoid fever at a time when there was not another case among more than 12,000 people using the same general water supply. That this household epidemic was due to the infected cistern water, supposed to be used only for ablution, there can scarcely be any doubt. As has been stated, this water was exceedingly impure, and bacteriological examination showed the presence in large numbers of a certain variety of the colon bacillus. One of those infected with typhoid fever in this household stated that she had occasionally used the soft water for washing her teeth; two others had used it in giving themselves treat-

ment by means of a nasal douch for catarrh; while the others did not remember having used the water except for washing the face and hands.

Another very striking illustration of the danger of using an infected water for any purpose was furnished during the epidemic at St. Clair, Mich., already referred to. At the earliest appearance of the epidemic at this place, a very intelligent family residing there decided to use every precaution possible against infection. Carbonated table water was used exclusively for drinking purposes. The epidemic had nearly passed, and this family, remaining free from infection, was congratulating itself, when one of its members was stricken with the disease. When interrogated by her physician, this patient remembered that she had always washed her teeth in the bathroom and had used the infected water for this purpose. These and other similar illustrations show the danger that there is in using an infected water for any purpose.

It should be borne in mind that foods and drinks diluted with water infected with the typhoid bacillus may not only carry the poison, but may serve as suitable media for its growth. The spread of typhoid fever by the milkman has been quite frequently observed. One of us investigated an epidemic of this kind a few years ago. In a village of 2,000 people there were about 30 cases of typhoid fever. All of these were in families supplied by a certain milkman who lived some distance in the country. Investigation showed that this man had recently had 2 cases of typhoid fever in his family.

The typhoid bacillus will retain its vitality in milk for thirty days or longer, or until it is destroyed by the growth of other organisms. It should be remembered that a given sample of milk may become infected after it has been boiled or otherwise sterilized. In our examination and inspection of army hospitals, we sometimes found hospital stewards who believed that they had done their whole duty when they supplied sterilized milk, and they did not exercise care necessary to keep flies from infecting the sterilized milk. The germ of typhoid fever will grow quite as rapidly and abundantly in sterilized as in raw milk. If sterilization is to be followed by subsequent infection, there can be no advantage in practicing sterilization. The specific germ of typhoid fever will not only grow in milk, but will continue to preserve its vitality in certain milk products. It will live in butter for thirty days or longer. Its vitality in cheese is determined by a number of conditions. In so-called cottage cheese, the typhoid bacilli may retain its vitality for several days, and this may serve as a means of infection.

The possibility of infecting drinking water by means of impure ice should not be overlooked. Experiments have shown that so far as bacteria are concerned, water does not by any means wholly purify itself in freezing, and ice may be the bearer of the typhoid infection.

Undoubtedly it has sometimes happened that a perfectly pure drinking water has been contaminated by impure ice.

There is a somewhat prevalent belief that the dilution of infected water with alcoholic drinks renders the chances of infection less. This belief has no scientific support. It is true that undiluted brandy or whisky will destroy the bacillus within a few minutes, but in either of these drinks diluted with an equal volume of water the typhoid bacillus may retain its vitality for at least a half an hour. The germ may live for some time in all kinds of wine; white and red, sweet and sour, and in ales and beer.

So-called soft drinks, which were extensively sold to soldiers in the various national encampments in 1898, probably had something to do with the spread of typhoid fever. Venders of such preparations were not at all particular as to the source of the water used in their manufacture, and if it happened to be infected, so much the worse for the consumers. Certainly, efforts to prevent typhoid fever in encampments can never be successful until the medical officer has under his control every possible means for the spread of the disease. If soldiers must have either alcoholic or so-called soft drinks, they should be furnished in a regular canteen under the supervision of the medical officers of the command.

Vegetables and fruits, especially those eaten raw, may carry the typhoid infection. For instance, the leaves of lettuce may become infected with typhoid stools while still in growth, or they may be sprinkled with infected water by the farmer who markets them or the green grocer who sells them.

It has been suggested that the milk of cows drinking infected water may contain the specific germ of typhoid fever. There is no probability that the Eberth bacillus taken into the stomach of a cow would reappear in the milk of the same animal, but it is possible that this germ might be eliminated in the feces of the cow and in the form of dust may find its way into the milk. We know that nearly every sample of cow's milk sold in the market contains the colon bacillus, which owes its presence in the milk not to passage through the milk glands, but contamination of the milk with the fecal matter of the cow.

Investigations made by Conn and Broadbent indicate that oysters grown in water infected with typhoid fever may serve as carriers of the specific infection. It is uncertain whether the infection results from taking some infected water in which the oyster lives along with the animal or from the bacillus incorporated in the body of the mollusk.

(*e*) Transportation of the bacillus on the person or in clothing.

That the infection of typhoid fever is often carried on the hands or in the clothing of nurses and other attendants there can scarcely be any doubt. This is probably one of the chief means by which the disease is spread through a family after its introduction. The mother or other attendant on the sick handles the food of the well without

disinfection of the hands. Superficial ablution with soap and water is not sufficient to destroy the vitality of this organism; thorough disinfection, with special attention to the material collected under the finger nails, is absolutely essential. At one of the division hospitals at Camp Alger in August, 1898, the members of this board observed the nurses, many of whom went directly from their duties in the typhoid wards to their mess tents and handled the food eaten by themselves and passed articles to their neighbors without even washing their hands. Another practice for which superior officers were responsible is undoubtedly accountable to a greater or less extent for the spread of typhoid fever among the soldiers at the various encampments in 1898: It was customary in some of the commands to take a fresh detail of men from the line each day as orderlies at the hospital. Each morning 100 men were detailed to attend those sick with typhoid fever, to place and adjust bedpans, and to carry the contents of these to the sinks and to disinfect them. These men, at least the majority of them, were wholly ignorant of the nature of infection; they had never had any training as nurses; they knew nothing about the desirability or necessity of being careful in order to prevent infecting themselves, and they knew less about means of disinfecting their hands soiled with typhoid discharges. At the close of the day these men were returned to their company tents, and the next morning a new detail of the same number went through with the same routine. A more effective means for the spread of typhoid fever could scarcely have been devised.

Many of the so-called cases of prolonged incubation after exposure to typhoid fever can be best explained by the supposition that the infective material is carried on the person some time before it finds its way into the alimentary canal. We shall have occasion further on to mention some of these cases. However, it may be stated here that undoubtedly a man may carry the typhoid bacillus under his finger nails, in his hair, or on his clothing for weeks, during which time he may travel across the continent, and at last accidentally introduce the germ into his alimentary canal and develop the disease. Some authorities lay much stress upon the period of incubation in the infectious diseases, and the International Sanitary Conference, which has attempted to prevent the spread of the plague from India, has based its most important measures upon what is supposed to be the maximum period of incubation of the disease. It must be evident that we know very little about the true period of incubation in most of the infectious diseases. If a hospital corps man who has been attending typhoid patients at Ponce, Porto Rico, leaves that place on a certain date, does not come in contact with other typhoid patients, and ten weeks later develops the disease, this certainly does not prove that the period of incubation in typhoid fever may be extended to ten weeks. This man may have carried the specific germ on his person or in his

clothing for the first eight out of the ten weeks and then accidentally introduced it into his alimentary canal. The fact that a belief in ten days as the maximum period of incubation in the plague has been the cause of the introduction of that disease from India into Europe should cause us to hesitate about laying too much stress upon so-called periods of incubation. The period of incubation of an infectious disease is the time which elapses from the introduction of the germ into the body until the development of the first symptoms of the disease, and unless we know definitely and positively the day or the hour of the introduction of the germ into the body, we can not determine the period of incubation. The number of days, weeks, or months the patient has carried the germ in his clothing has nothing to do with the period of incubation.

Experimental evidence shows that pure cultures of typhoid fever bacilli will retain their virulence when poured upon cotton, linen, or woolen cloth for from two to three months, and it is altogether possible that the infection may be carried in a blanket roll for a much longer time. The evidence which we will bring forward in connection with the history of typhoid fever in our Army during the late war with Spain will show quite conclusively, we think, that infected clothing, bedding, and tentage had much to do with the spread of typhoid fever and will demonstrate the necessity in attempting to eradicate this disease from an infected command of disinfecting all the above-mentioned articles.

The personal and bed linen of patients sick with typhoid fever when soiled with discharges from the kidneys or bowels should be immediately immersed in a properly prepared disinfecting solution. When such articles are thrown aside without previous disinfection, flies may carry the infection from the stains to articles of food, and, moreover, after the material dries, handling these articles may scatter the infective material through the air in the form of fine dust.

(*f*) Dissemination by flies.

We are satisfied that the evidence furnished in our studies, to be detailed later, is sufficient to show beyond reasonable doubt that the most active agents in the spread of typhoid fever in many of the encampments in 1898 were flies. The reason for coming to this conclusion will be given in detail later, but may be summed up here as follows:

(1) The latrines contained fecal matter specifically infected with the typhoid bacillus.

(2) Flies alternately visited and fed upon this infected fecal matter and the food in the mess tents. More than once it happened when lime had been scattered over the fecal matter in the pits, flies with their feet covered with lime were seen walking over the food.

(3) Typhoid fever was much less frequent among members of messes who had their mess tents screened than it was among those who took no such precaution.

(4) Typhoid fever gradually died out in the fall of 1898 in the encampments at Knoxville and Meade with the disappearance of the fly, and this occurred at a time of the year when in civil practice typhoid fever is generally on the increase. We will take the encampment at Knoxville as a special object of study in this inquiry. Most of the regiments at Knoxville came from Chickamauga, where they had become seriously infected with typhoid fever. The specific germ of this disease was carried from Chickamauga to Knoxville in the bodies of the men, on their persons, in their clothing, in their blankets, and in their tents. The first pits at Knoxville contained before the first twenty-four hours had passed after the arrival of the troops fecal matter infected with the typhoid bacillus. Flies swarmed everywhere. Instead of abating, the disease increased. The soldiers were using the same water used exclusively by the inhabitants of West Knoxville, and among the latter there was not at that time a case of typhoid fever. Certainly the disease was not disseminated through the drinking water. The locations of the regimental camps were ideal. The ground had never been occupied by troops before, consequently was not polluted, but as has been stated, typhoid fever continued to increase until the cooler weather of October lessened the number of flies and simultaneously typhoid fever diminished. It has been suggested that typhoid fever gradually disappeared among these troops because all the susceptible material had been used up. Fortunately, we can give a definite answer to this suggestion. The division at Knoxville received several regiments of recently recruited troops who had not been at Chickamauga. These regiments arrived early in September. They soon were infected with typhoid fever, but the disease disappeared among these new regiments simultaneously with its disappearance among the older troops. Certainly it can not be said that the disappearance of the disease among these recently recruited regiments was due to the exhaustion of susceptible material.

Flies may carry infected matter from the persons of those sick with the disease and deposit it in the drink or on the food of the healthy. To those who have seen flies feeding upon the fecal matter smeared over the buttocks of patients or have seen them crawling into the mouths of the unconscious typhoid subject, nothing more is necessary than to mention this possible means of the dissemination of the disease. When flies abound, the man sick with typhoid fever should be protected from the annoyance of this insect, not only because the patient will be more comfortable, but this protection is desirable in order to prevent the spread of the disease through the agency of these pests.

Flies may carry the infected material from soiled clothing or bedding and deposit it upon food. We have already mentioned this fact and have recommended that soiled personal and bed linen be immediately immersed in a disinfecting solution.

Near the rear end of one of the regimental hospitals inspected by

us we found a half dozen or more bed pans, all more or less soiled with stools undisinfected, swarming with flies, which may have visited the mess tents later. No undisinfected material should be left exposed to the flies.

CONDITIONS INFLUENCING THE SPREAD OF TYPHOID FEVER.

The prevalence of typhoid fever is apparently influenced largely by season. This certainly is true in the north temperate zone, both in Europe and America. It is most prevalent during late summer and the fall and is least prevalent during the spring months. As a rule the increase in frequency begins to be observable in July and continues, according to the season and local conditions, to increase until the last of October or November. In December, as a rule, the decrease in frequency is noticeable and continues until the minimum is reached in March, April, and May. The researches of Flint, Wood, and others showed this to be true in the United States soon after the medical profession learned to distinguish between typhus and typhoid fevers, and more recent authorities in this country have confirmed this observation. Curschmann, Fiedler, and others find the same to be true in Germany, and Murchison, in his classical studies of typhoid fever, showed that season has a like effect on the prevalence of this disease in Great Britain.

While it is probably generally true that typhoid fever is most prevalent in the fall, great epidemics of this disease do not always occur at this season of the year. In fact, the greater prevalence of typhoid fever in the fall of the year is not so marked now as it was thirty years ago, because of the altered conditions under which we live. This relationship has always been more evident in a rural than in an urban population. At present the most striking epidemics of typhoid fever are those that occur in cities and are due to an infected water supply. Season affects these epidemics to the extent to which it modifies the chances of water infection. Many of these epidemics within recent years have occurred in the spring of the year, during the months in which, according to the general rule, the prevalence of typhoid fever should be at a minimum. Water infection is likely to occur when the snow melts and the ice breaks up, and is due to infected material deposited on the surface during the winter. As we have already seen, the epidemic at Plymouth, Pa., was accounted for in this way; another of the epidemics already referred to, that at St. Clair, Mich., occurred in March and April. Epidemics of typhoid fever due to an infected water supply are quite independent of season, except as stated above. On the other hand, epidemics due to insects and those caused by the dissemination of the germ in the form of dust are more likely to occur during late summer and autumn. The same is probably true of some epidemics in rural places due to infected wells. Contaminated material is more widely disseminated in sum-

mer and fall than during any other season of the year. In the summer time or in the early fall a typhoid stool thrown on the surface of the ground may be scattered far and wide by the wind; may be carried on the feet of men and animals; may be washed into wells or springs, and, in short, its wide dissemination is more likely to occur at this season of the year than at any other. These facts, in our opinion, sufficiently explain the relation between typhoid fever and season so far as such a relation exists.

INFLUENCE OF AGE ON TYPHOID FEVER.

That typhoid fever is much more likely to occur in persons of a certain age than in others younger or older is shown by voluminous statistical evidence. However, we must not be too hasty in arriving at conclusions on this point. First, we will give the general statements and will then briefly discuss the same.

Curschmann states:

> Undoubtedly early adult life especially predisposes the individual to typhoid fever. Individuals from 15 to 35 years of age are in greatest danger of this disease. In my experience at least four-fifths of all cases have occurred among people within these limits, and more than half (about 56 per cent) have been between 15 and 25 years of age. Between 30 and 35 years the per cent begins to fall, and from 35 to 40 it sinks rapidly. After the fiftieth year the per cent of morbidity from this disease falls to a fraction. In old age typhoid fever is seldom seen. During the first year of life, as is the case with most infectious diseases, typhoid fever is rare. From the first to the fifth year morbidity from this disease increases. From the fifth to the fifteenth year the disposition to typhoid fever is increased and is greater than it is during the period from 35 to 40 years.

Murchison reported 52 per cent of his cases among individuals from 15 to 25 years of age. Fiedler found 58.8 per cent of his cases to range from 20 to 30 years of age, while only 3.4 were over 40 and 0.7 per cent over 50.

While percentages of morbidity and mortality do not always correspond, the following figures from a table prepared by Brouardel, giving the ages of those dying from typhoid fever in Paris from 1880 to 1889, undoubtedly gives a correct idea of the relative prevalence of this disease in persons of different ages. This table is of value on account of the large number of cases upon which it is founded, the number amounting to 16,036.

Deaths from typhoid fever in Paris from 1880 to 1889.

Up to 1 year	36	30 to 35 years	1,197
1 to 5 years	1,041	35 to 40 years	771
5 to 10 years	1,265	40 to 45 years	457
10 to 15 years	1,386	45 to 50 years	380
15 to 20 years	2,991	After 50 years	583
20 to 25 years	3,896		
25 to 30 years	2,081	Total	16,036

This apparent predisposition of early manhood to typhoid fever may be partially explained. In the first place, it is at this time of

life that man roves about most, obtaining his water and food from the most diverse sources, and it must be evident that his chances of infection are greater than they are earlier or later in life. In the second place, it is possible that many of those who have reached 40 years of age have acquired a certain immunity to the disease without ever having developed it in recognizable form. The evidence that we shall give later that short diarrheas often give at least temporary immunity to typhoid fever has been, to us at least, quite convincing. How long this immunity may continue in different individuals we have no means of determining. The infant taking his nourishment exclusively from his mother's breast has but little opportunity of being infected with typhoid fever. As he grows up and seeks his food and drink from other sources, the danger of typhoid fever infection increases in direct proportion to the diversity of the sources from which he draws his supply. During the period of life when he mingles most largely and most promiscuously with other men, the danger of infection is increased. Later in life he becomes tethered by his habits. He visits fewer places, cares less for the society of strangers, and the chances of infection are decreased. While sickness from typhoid fever is much more frequent in early manhood, the per cent of deaths among cases is much greater late in life. In general, other things being equal, the per cent of mortality increases with advancing years and ranges from 2 per cent in early childhood to more than 50 per cent in old age. The mortality in persons from 15 to 35 years of age averages about 7.5 per cent, but of course varies considerably in different outbreaks and is modified to some extent by the individual condition of patients.

THE INFLUENCE OF SEX.

Hospital statistics taken alone indicate that typhoid fever is more prevalent among men than among women. However, this is not true, and the apparent greater prevalence among men as shown by hospital figures is due to the fact that more men than women are treated in hospitals. Moreover, all hospital statistics do not show a greater per cent of cases among men. In London from 1848 to 1861, according to Murchison, 2,432 cases of typhoid fever were treated in the fever hospital; of these, 1,211 were males and 1,221 were females. There is not the slightest reason for believing that sex has any influence upon susceptibility to typhoid fever. It is probably true that on a whole a larger number of men than women have the disease, but this is due to the fact that men are more frequently exposed to infection; they travel about more; they take their food and drink from more diverse sources, and consequently the chances of infection are greater.

Pregnancy and the puerperal state apparently give some degree of temporary immunity to typhoid fever, or at least decrease the susceptibility to this disease. Curschmann states:

Griesinger finds typhoid fever to be very rare in the puerperal state, and believes that nursing mothers are especially protected against this disease; in this

he agrees with Rokitansky, and I myself have only twice seen typhoid fever appear among women in the puerperal state and very seldom during lactation.

Pregnancy is also supposed to lessen susceptibility to this disease. However, the probabilities are that the relatively small number of cases observed among women during pregnancy and the puerperal condition is due to the fact that during these periods women are less exposed to infection than at other times.

INFLUENCE OF FATIGUE.

Bodily fatigue and mental worry apparently increase susceptibility to typhoid fever. The effect of fatigue is especially observable in armies. However, there are certain points connected with the study of this subject that are not altogether clear, and there is a possibility of falling into error in formulating conclusions concerning the relation between fatigue and typhoid fever. In the first place, exhaustive physical exertion, as is instanced after prolonged forced marches with raw troops, may cause a continued fever which resembles typhoid fever clinically, but is wholly different in its etiology and pathology. This fever of exhaustion may continue for two or three weeks and may be mistaken for typhoid fever. However, it never occurs in epidemic form. It has been observed that within two or three days after a forced march or other exhaustive exercises the number of typhoid-fever cases increases. The short time elapsing between the exercise and the appearance of the fever does not justify the belief that infection occurred during or after the exercise, but in many of these cases infection must have occurred before the physical exercise, and the only effect attributable to this is that of causing the more speedy development of the disease in persons already infected. It is true that physical exhaustion may and probably does increase susceptibility to typhoid fever; this probably is brought about by lowering the resistance of the body against an infection.

INFLUENCE OF SOCIAL POSITION.

Typhoid fever is not more prevalent among the poor than among the rich. Indeed, it frequently prevails more extensively among the better-to-do classes than among those suffering from poverty. It was frequently told us while making our inspection of the camps that companies recruited from the wealthier classes had more typhoid fever than those from the working classes. This may be due to the fact that these men, having more money to spend, indulged more largely in purchases from venders of articles of food likely to be infected. This subject will be referred to again in the body of our report. In civil practice also it is observable that typhoid fever is not a disease of poverty, but, on the other hand, it is more likely to afflict those who are pecuniarly well-to-do. Furthermore, this disease is more prevalent among the well-nourished, apparently healthy and

robust than it is among the more delicate. We have already seen that man is most susceptible to this disease in early adult life, when he is supposed to be possessed of the greatest vitality. The full-blooded, vigorous man is quite as likely to fall a victim of this disease as his anæmic weak brother. So far as the influence of vocation is concerned there is no evidence that one occupation more than another creates a special disposition to this disease, except when the occupation brings the individual into more frequent and dangerous communication with the bacillus. Physicians, nurses, and laundresses show a large per cent of typhoid fever, but this is due to the fact that their work brings them into close contact with the stools of typhoid-fever patients. Other callings may place men so that they are more likely to drink typhoid-infected water. It is for this reason that dock hands, stevedores, and sailors show a large percentage of typhoid fever.

INFLUENCE OF EXPOSURE TO COLD.

It is quite widely believed that exposure to cold increases susceptibility to typhoid fever. In most reported cases supposed to illustrate this point the fever follows so closely upon the exposure that the infection must have occurred previously. The probabilities are that in most of these cases the supposed exposure to cold was due to the chilly sensations likely to accompany the prodromal stage of this disease.

INFLUENCE OF OTHER DISEASES.

The influence of other diseases upon susceptibility to typhoid infection is interesting, but is also one about which we must be slow to draw conclusions, because the evidence is likely to be misleading. Curschmann states that the acute infectious diseases, especially during the febrile stage, protect against infection with typhoid fever. He also has observed that during convalescence from other acute infectious diseases there seems to be partial and temporary immunity to typhoid fever. These opinions are based upon personal observations in several great epidemics, notably that of Hamburg from 1885 to 1888, in which 15,804 cases were reported. However, we must bear in mind that one sick with scarlet fever or some other acute infectious disease is not for the time being exposed to typhoid infection to the same extent that healthy people are. The Hamburg epidemic was due to an infected water supply, and it is more than likely that individuals suffering at that time from other acute infectious diseases drank proportionately less unboiled water than others did. However, there may be truth in Curschmann's observations; we simply suggest caution in accepting them as conclusive. The fact that malaria and typhoid fever may simultaneously exist in the same individual will be discussed later; and Curschmann himself states that he has seen along the Rhine malaria and typhoid fever prevalent in one place at

the same time, but he makes no mention of the coexistence of this disease in the same individual. The same great clinical teacher has observed that persons with tuberculosis in an advanced stage seldom become infected with typhoid fever, notwithstanding the fact that tuberculous patients are often kept for long periods in the same hospital wards with typhoid-fever cases. He thinks, however, that in these cases the immunity to typhoid fever should be chiefly attributed to the emaciations accompanying tuberculosis; and he states that typhoid fever is also rare among those suffering from malignant diseases, from constitutional diseases, especially from diabetes. His belief that the immunity to typhoid fever observed in advanced cases of tuberculosis is due to the emaciations rather than to specific infection with the tubercle bacillus is supported by the observation that individuals with latent tuberculosis fail to show this immunity to typhoid fever, and he adds that every physician of large experience has unfortunately had opportunity to observe the rapid progress of tuberculosis in such cases during illness with typhoid fever. He states that individuals suffering from chronic nervous diseases, in so far as those maladies occur among those of susceptible age, show no immunity to typhoid fever.

The relation of preexistent diseases of the stomach and intestines to susceptibility to typhoid fever is an interesting one. On this point we make the following quotation from Curschmann:

> The assertion that errors in diet, with consequent gastric and intestinal catarrh, induce typhoid fever is no longer open to discussion. This formerly accepted view was founded upon false conclusions drawn from different observations in accordance with the differently accepted ideas concerning the etiology of the disease. It undoubtedly happened that the early symptoms of typhoid fever were often confounded with those of simple gastro-intestinal catarrh; especially is this likely to occur in *typhus ambulans* when the true nature of the disease is often not recognized until a chilly febrile relapse compels the individual to seek his bed. On the other hand, it is conceivable that errors in diet, with their consequences, may favor the development of the contagion, and it is not improbable that in individuals already infected they may hasten the appearance of the disease. This view is supported by the frequently observed fact that relapses follow dietetic errors. The supposed susceptibility to typhoid fever after acute and chronic diseases of the stomach has been attributed to the altered production of hydrochloric acid. From experiments made outside of the body upon other pathogenic germs which infect by way of the intestinal tract, this assumption appears probable, and although the typhoid bacillus is relatively more resistent to the action of the gastric juice than the other pathogenic micro-organisms, it is not to be doubted that marked diminution of the free hydrochloric acid does materially improve the chances of this germ passing uninjured into the intestines. Theoretically, on the other hand, although we have no practical evidence bearing on the subject, it might be assumed that gastric affections accompanied by hyperacidity protect against typhoid fever.

Certainly, with our present knowledge concerning the etiology of typhoid fever, no one will hold that this disease is ever caused by errors in diet or by the consequent gastric and intestinal catarrh. However, there still remains the question whether or not catarrhal

conditions of the stomach and intestines place these organs in a better condition for the reception and retention of the typhoid bacillus. The members of this board began this investigation, all believing that especial attention should be given to the study of the relation between preceding gastric intestinal disturbances and typhoid fever. We were unanimously of the opinion, which seems to be quite generally held, that acute diseases of the gastro-intestinal tract render the individual more susceptible to subsequent infection with typhoid fever. However, our studies have forced us to come to the following conclusions concerning the relation between typhoid fever and preceding temporary disorders, including those diagnosed as diarrhea, enteritis, gastro-enteritis, gastro-duodenitis, intestinal catarrh, gastro-intestinal catarrh, gastric fever, and simple indigestion:

(1) The temporary gastro-intestinal disturbances of May and June had but little if any effect upon subsequent infection with typhoid fever. We mean by this that men who are reported as having such temporary disorders during the time mentioned were found to be no less and no more susceptible to subsequent typhoid infection.

(2) The temporary gastro-intestinal disturbances of July and August apparently gave a certain degree of immunity against subsequent infection with typhoid fever.

(3) The majority of men who developed typhoid fever did not report at sick call previous to the appearance of this disease.

(4) In a considerable per cent (a little more than one-third) of the cases which are recorded as having been preceded by some intestinal disturbance, the preceding illness was so closely followed by typhoid fever that we must regard the former as having occurred within the period of incubation of the latter.

In order to show the evidence upon which the above given conclusions are founded, we offer the following statements:

We have investigated the medical history of each of 12,484 men at Chickamauga. With the names of these men before us, we have ascertained the complete medical history of each one, so far as the regimental and hospital records show.

Of these 12,484 men, 5,237 had some intestinal disturbance. As has already been stated, the names given to these intestinal disorders by the surgeons were numerous and diversified, but we have included all under the general head of intestinal disorders.

The 5,237 men who had some intestinal disorder furnished 672 cases of typhoid fever.

This shows a percentage of 12.83.

The 7,247 men who had no recorded intestinal disturbance furnished 2,091 cases of typhoid fever.

This shows a percentage of typhoid fever among these men of 28.85.

These figures show that the men who had temporary intestinal disorders furnished less than one-half as many cases of typhoid fever as

did the men who had no preceding intestinal disorder; but the above-mentioned figures are misleading because in 265 of the 672 cases of typhoid fever that occurred among men who had had some intestinal disorder, the recorded intestinal disorder is so closely connected with the subsequent typhoid fever that it must be regarded as a part of the prodroma of typhoid fever.

A corrected statement would read as follows.

Four thousand nine hundred and seventy-two men who had had some preceding intestinal disorder furnished 407 cases of typhoid fever.

In other words, the percentage of typhoid fever among the men who had had temporary intestinal disorder was 8.18.

Seven thousand five hundred and twelve men who had had no preceding intestinal disorder furnished 2,356 cases of typhoid fever.

In other words, the percentage of typhoid fever among the men who had had no intestinal disorder was 31.36.

The facts might be stated in another way as follows:

Among 2,763 cases of typhoid fever 2,356 were not preceded by any intestinal disorder.

In other words, the percentage of cases of typhoid fever which were not preceded by any intestinal disorder was 85.27.

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Respectfully submitted.

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